NOV - 20¢

POPULAR SCIENCE

MONTHLY

HOW FLYERS BREATHE AT EXTREME HIGH ALTITUDES

PAGE 77

When Russia Fights Japan

PAGE 65

Straight steer *by Fisher*

The Army-Navy "E" flies above three Fisher plants for excellence in aircraft production and from two others for tank production, while the Navy "E," with three stars, is flown by still another Fisher plant for its naval ordnance work.

TWO amazing instruments — the gyro horizon and the directional gyro — help to give the American bombardier his big moment. Both are designed by Sperry Gyroscope, and built by Sperry and Fisher Body.

In precision flying, these delicate indicating instruments help a pilot to keep on his designated target. In blind flying or night flying they help him keep the true course to his objective.

Precision beyond anything ever attempted by Fisher is a "must" in their manufacture. Rare and special skills are necessary every step of the way.

Craftsmanship gave us the answer, just as it gave us the answer to bomber, tank and anti-aircraft gun problems.

Craftsmanship has never yet let us down.

And today you may be certain that as long as there's a micrometer and a microscope left in the world, our men will do their best to give their brothers in the air a straight steer — by Fisher.

armament BODY BY *Fisher*

DIVISION OF GENERAL MOTORS

"Sure I helped make that 80,000,000 mile road test of synthetic passenger car tires"

says Aetna Welfare Nurse

HERE'S HOW HUNDREDS OF LEADING COMPANIES AND CAR OWNERS JOINED IN MAKING THE GREATEST AUTOMOBILE TIRE ROAD TEST OF ALL TIME—MONTHS BEFORE PEARL HARBOR.

One morning three years ago this Aetna Life Insurance Company nurse noticed a new kind of tire on her car. "It's a test," the maintenance man said. "Those tires are more than half synthetic Ameripol." So she drove them and made her report. And hundreds of other passenger car owners did the same thing—testing these B. F. Goodrich tires for a total of 80,000,000 miles.

Today we're making tires in which 99% of the natural rubber has been replaced by "GR-S" synthetic from government plants. And the experience gained in that first test has helped us to make them dependable, high-quality tires.

Some of these tires are now available for car owners who qualify, but most of our synthetic rubber production is still needed to supply our armed forces. The "rubber crisis" is very real—and very present. So it's still patriotic to save your present tires—and not to drive a single needless mile.

A few of the many companies that helped make this test

American Can Co.
Baltimore & Ohio Railroad
The Borden Co.
General Outdoor Advertising Co.
General Baking Co.
Gulf Oil Corporation
Geo. A. Hormel & Co.
Kellogg Company
New York Telephone Co.
Pet Milk Sales Corp.
Railway Express Agency
Socony-Vacuum Oil Co.
Standard Brands, Inc.

Awards to 7 plants

In war or peace

B.F.Goodrich

FIRST IN RUBBER

Completely at Sea

ABOUT WHAT BATTERY TO BUY?

BUY THE BATTERY THAT IS THE CHOICE OF EXPERTS

Why not let the experts help chart your course when you buy your next battery?

A million-mile, trans-ocean flying record has just been established by a Pan American Clipper equipped with Auto-Lite batteries. Auto-Lite batteries, too, are specified for service with our fighting forces in tanks, half-tracs, jeeps . . . wherever dependable power counts most.

Make sure you get the longer life . . . the extra power you need today. Make your next battery an Auto-Lite—specified as original equipment by leading automotive engineers.

The "Million-Mile" Pan-American Clipper uses AUTO-LITE Batteries for its ocean-spanning record-breaking flights.

AUTO-LITE Batteries have been proved under fire on every fighting front.

AUTO-LITE means AUTO-LIFE

TOLEDO, 1 **AUTO-LITE BATTERY CORPORATION** OHIO

Manufacturing Plants at: Niagara Falls, Indianapolis, Atlanta, Oakland, Oklahoma City, Toronto

BACK THE ATTACK WITH WAR BONDS

AUTO-LITE BATTERIES

Popular Science Monthly for November, 1942. Volume 143, Number 5. Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 2, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Yearly subscriptions in the United States, $2.00.

INCREASE YOUR "FIRE POWER" ON THE PRODUCTION FRONT!

You can increase your "fire power" on the production front—and increase your chances for prosperity in tomorrow's victory-world—by enrolling right now for a low-cost, short-term War Course with the International Correspondence Schools.

I. C. S. War Courses are not just textbooks—they are a combination of profusely illustrated texts written by recognized practical authorities and edited specially for home study. Lessons are examined by members of the I. C. S. staff of trained teachers, whose methods are approved by leading educators.

Find out now how simple it is to get sound, practical I. C. S. training in a short time, at surprisingly low cost. The coupon will bring you complete information, without obligation. Mail it today!

LEARN MORE—
TO PRODUCE MORE—
TO INSURE YOUR FUTURE!

INTERNATIONAL CORRESPONDENCE SCHOOLS

HELPING TO TRAIN AMERICANS FOR VICTORY

SPECIAL TUITION RATES FOR MEMBERS OF THE ARMED FORCES ★

BOX 7643-K, SCRANTON 9, PENNA.

Gentlemen: Please send me (without cost or obligation) full information regarding the Special War Course which I have marked X:

- ☐ Accounting
- ☐ Air Pilot
- ☐ Airplane Drafting
- ☐ Architecture
- ☐ Aviation Engines
- ☐ Aviation Mechanics
- ☐ Bookkeeping
- ☐ Carpentry
- ☐ Chemistry
- ☐ Civil Engineering
- ☐ Cost Accounting
- ☐ Diesel Engines
- ☐ Electrical Engineering
- ☐ Foremanship
- ☐ Gas and Electric Welding
- ☐ High School
- ☐ Industrial Electrical Engineering
- ☐ Internal Combustion Engines
- ☐ Machinist's Apprentice
- ☐ Machine Shop
- ☐ Managing Men at Work
- ☐ Mechanical Drawing
- ☐ Mechanical Engineering
- ☐ Mold Loft Work
- ☐ Motor Boat Navigation
- ☐ Plastics
- ☐ Plumbing and Heating
- ☐ Practical Electricity
- ☐ Radio
- ☐ Reading Blueprints
- ☐ Secretarial
- ☐ Sheet Metal
- ☐ Ship Drafting
- ☐ Ship Fitting
- ☐ Shop Practice
- ☐ Structural Engineering
- ☐ Surveying and Mapping
- ☐ Textiles
- ☐ Tool Designing
- ☐ Toolmaking
- ☐ Traffic Management

My name..... *My age*.....

My present job..... *Length of time with present employer*.....

The "job ahead" for which training would fit me.....

My address..... *City*..... *State*.....

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 143 NO. 5

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS for NOVEMBER, 1943

Cover: Kodachrome by Lieut. C. D. Pierce, Courtesy U. S. Army Air Forces

News

Automobiles

Home and Workshop

PUTTING THE PRECISION IN PRECISION BOMBING

OUR bombardiers' boast that they can "hit a pickle barrel at 10,000 feet" is backed up by a mathematical and mechanical miracle. When a bomb is dropped from a plane traveling 200 miles an hour, miles above the earth, it is a job for an Einstein to figure just where it is going to land. Good as they are, our bombardiers are not expected to be mathematical wizards. Their amazing skill in picking off enemy factories, rail yards, and military installations is due to the wonderful tool with which they have been provided —the precision bombsight. You may have wondered how this Axis-beating instrument works. An article in our December issue will explain the complicated mathematical problems involved and the ingenious mechanism that solves them.

Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Charles McLendon, Stephen P. Glennon, Vice-Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

Yearly subscriptions to United States and its possessions, $2.00; Canada, $2.00; foreign countries, excepting Canada, $3.00. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

She Still Has "The Voice With A Smile"

War traffic keeps her busier than ever but she manages to keep calm and pleasant.

She still has "The Voice With A Smile" even when the lights are thick on the Long Distance switchboard and the circuits are crowded. Even when she has to ask you to —

"Please limit your call to 5 minutes. Others are waiting."

That's to help everybody get better service and you couldn't ask for a better reason than that.

BELL TELEPHONE SYSTEM

Coming Next Month

GUN POWER will make history when the Allied grand fleets force a showdown with the elusive Japanese Navy. The big rifles that speak from the turrets of our men-of-war are the most powerful instruments of destruction ever used at sea. Arthur Grahame tells how they evolved from the simple brass tubes that were the first naval artillery, 500 years ago.

MOSQUITOES have been bad in Berlin lately —not the kind that can be shoed away with a spray gun, either. They're nasty little British fighter-bombers made almost entirely of plywood and capable of hauling a troublesome amount of explosive at fighter-plane speeds. William S. Friedman tells you what you want to know about this scourge of the Nazis.

THAT POSTWAR CAR of yours—what will it look like, and how will it perform? When the automobile manufacturers get into production on new models, we can expect many radical changes. An article gives you a preview of the automobile of the near future—its design, its power plant, and the comforts and conveniences it will give the motorist. Don't miss this glimpse of the highways of tomorrow.

INVENTORS ARE EXCITED over proposed changes in our patent laws. Legislation before Congress would substitute "compulsory licensing" for the absolute control now enjoyed by inventors over their discoveries. You'll want to know the facts about this controversy. Would the proposed law remove the incentive that has made Yankee ingenuity proverbial throughout the world?

STEEL IS THE STUFF that will win the war. We hear a lot about guns, tanks, and ships, but they all go back to this raw material. To show you what steel is and where we get it, Alden P. Armagnac takes you on a tour of the flaming furnaces of "Victory Valley" on the Monongahela, one of the great steel-making centers that feed the "Arsenal of Democracy."

WHEN YOU USE A LADDER, be sure it is the right kind. Personal safety and good work both require it. If a ladder is just a ladder to you, it will pay you to read up on the subject. A practical article describes the different types, from the lowly stepladder to the long extension job, and tells which is best for each purpose.

NOW! A NEW CARTOON CHARACTER FOR HOME PROJECTOR OWNERS!

Never before seen in 8mm. and 16mm. movies! Now! KIKO—funniest cartoon character yet—comes to your screen in fast-action movies. Wait until you see the children's glee at watching him! Here's new pleasure for every projector owner! Give the joy of "Kiko" films to your own family...to other projector-owning families! They're new! They're fun! They're something to own!

8 RIOTOUS SUBJECTS YOU CAN OWN

1. "The Big Fight"
2. "Cleaned Out"
3. "The Foxy Fox"
4. "Hail The King"
5. "Ostrich Troubles"
6. "On The Scent"
7. "Danger On Ice"
8. "Red Hot Rhythm"

*©Terrytoons, Inc.

"TRACK MEET THRILLS"

A thrill a second! Champion track men performing at their best! Pole vault! Broad jump! High jump! Discus! Hurdles! Other events! Own this movie now!

FREE Illustrated Catalog describing all 8 hilarious "Kiko" films. Also new De Luxe Castle Films' Catalog describing 98 thrilling home movies! Send coupon **TODAY!**

ON SALE AT YOUR PHOTO DEALER NOW!

LOW COST Per Subject!

8mm. 50 ft.	$1.75
8mm. Complete	5.50
16mm. 100 ft.	2.75
16mm. Complete	8.75
16mm. Sound-On-Film	17.50

CASTLE FILMS INC.

CASTLE FILMS

RCA BLDG. NEW YORK, 20 — FIELD BLDG. CHICAGO, 3 — RUSS BLDG. SAN FRANCISCO, 4 — Address Nearest Office

Please send FREE "KIKO" Catalog. Also Castle's new FREE De Luxe Film Catalog.

*Name*_____

*Address*_____

*City*_____ *State*_____ PS-11

MIDWEST'S best and ONLY customer...TODAY!

THE French have a proverb—"The more things change, the more they are the same." How true that is of Midwest Radios! Once we counted satisfied Midwest Radio owners in hundreds of thousands . . . in every part of the globe. Today, we have only one customer—America's fighting man. But you'll find him, too, in every corner of the world—and, by his side, radio or electronic equipment, built by Midwest, giving him the same dependable performance that for 22 years has made Midwest Radios an international favorite.

When Victory is won, a new era in radio and electronics will open for you who have been forced to stand by while a greater need was being served. What this new era will bring, it would be foolish to conjecture. But, of this you can be certain—Midwest will be back again with highest quality radio receivers, and with Factory-To-You savings of up to 50%—*as always!*

★ AT LEAST 10% IN WAR BONDS

MIDWEST RADIO CORPORATION

Department 59-E CINCINNATI, OHIO

★ SEND FOR FREE BOOKLET!

A 24-page booklet "Radio—The Eyes and Ears of Our Armed Forces" will be sent FREE on your request if accompanied by 10c in stamps or coin for which we will send you a War Savings Stamp.

EVERY drafting board is a battlefield across which move tanks, guns, planes and ships. Every new weapon must pass through this design stage before it reaches production and moves on to the literal fighting fronts.

Learn now to fight as a *trained* draftsman and help your country while you help yourself.

Freedom to pick your own battlefield in fighting for success in life is one of your great heritages as an American. And in choosing the drafting board, you know that big, well-paid jobs are to be won there. Thousands of successful men made their start in just that way.

Many of today's draftsmen will be among tomorrow's leaders. *You* can learn drafting—at low cost—by studying an I. C. S. Course in your spare time! Mail this coupon *today* and you're getting into communication with a real future.

J. E. SMITH, President,
National Radio Institute
Established 25 Years
He has directed the training of more men for the Radio industry than anyone else.

I WILL SEND A SAMPLE to PROVE I can Train You BE A RADIO

Vital Jobs Like These Go To Men I Train

Communication Station Operator—

$100 a Month in Own Business— For several years ... for myself ... month. ... crossed. ... my start."—A. J. ... Texas Ave., ...

Lieutenant in Signal Corps— ...

$15 a Week in Spare Time— ... JOHN ... Kansas ... Denver ...

Chief Operator Broadcasting Station— ... Chief Operator ... HOWARD J. ... Madison St. ... Michigan

MORE RADIO TECHNICIANS NOW MAKE $50 A WEEK THAN EVER BEFORE!

I will send you a sample Lesson, "Getting Acquainted with Receiver Servicing," to show you how practical it is to train for Radio at home in spare time. It's a valuable lesson. Study it—keep it—use it—without obligation! Tells how "Superhet" Receivers work, gives hints on Receiver Servicing, Locating Defects, etc. 31 illustrations. And with this Lesson I'll send my 64-page illustrated book, "Win Rich Rewards in Radio." It describes many fascinating jobs Radio offers, explains how N.R.I. trains you at home for good pay in Radio. Get both FREE by mailing Coupon!

RADIO SERVICING ... Technician ... money ... time ... RADIO OPERATORS ... at sea ... work in ... casting and other types of Stations.

Extra Pay in Army, Navy, Too

Men ... get into military service ... Learning Radio helps ... more interesting duties, MUCH HIGHER PAY ... prepares for good Radio jobs after service ends. Over ... men now enrolled

A TESTED WAY TO

LESSON FREE

at Home in Spare Time to

TECHNICIAN

There is a Shortage of Radio Technicians. Many Good Jobs are Open!

There's a big shortage today of capable Radio Technicians and Operators. Fixing Radios pays better now than ever before. With new Radios out of production, fixing old sets which were formerly traded in, adds greatly to the normal number of service jobs.

Broadcasting Stations, Aviation and Police Radio and other Radio branches are scrambling for Operators and Technicians. Radio Manufacturers now working on Government orders for Radio equipment, employ trained men. The Government, too, needs hundreds of competent civilian and enlisted Radio men and women. You may never see a time again when it will be so easy to get started in this fascinating field.

Be Ready to Cash in on Jobs Coming in Television, Electronics

Think of the NEW jobs that Television, Frequency Modulation, Electronics, and other Radio developments will open after the war! You have a real opportunity. I will train you to be ready to cash in when Victory releases the amazing wartime Radio developments for peacetime uses!

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

Right now, probably in your neighborhood, there's room for more spare and full time Radio Technicians. Many N R I Students make $5, $10 a week EXTRA money doing Radio repairs in spare time while learning. I send EXTRA MONEY JOB SHEETS that tell how to do it! My "50-50 Method"—half studying and testing real Radio circuits in half learning from easy to grasp, illustrated lessons—is a tested, proved way to learn Radio at home in spare time. Think how much practical experience you'll get by building the Superhet and Measuring Instrument illustrated at right—by conducting 60 sets of experiments on these and other circuits you build with parts I supply! Within a few months you can be ready to run your own Spare Time Shop, fix the Radios of your friends and neighbors—get paid while learning!

START NOW Toward Radio's Rich Rewards!

MAIL THE COUPON. I'll send you the FREE Lesson and my valuable, 64 page, illustrated book. They're packed with facts about Radio. You'll see snapshots and letters from men I trained, so you can know what N R I did for others. You'll read a description of my Course—"50-50 Method"—8 Experiment Kits—Extra Money Job Sheets. You'll have my free Lesson to keep. And you'll see many fascinating jobs Radio offers and how YOU can train at home. No obligation—no salesmen will call. If you want to JUMP YOUR PAY—Mail Coupon in an envelope or pasted on penny post card. J. E. SMITH, President, Dept. 3MP3, National Radio Institute, Washington 9, D. C.

You Build These and Other Radio Circuits with 6 Big Kits I Send

A M. SIGNAL-GENERATOR (above). Build it yourself! Provide amplitude-modulated signals for test and experimental purposes. Gives valuable practice!

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON **FREE**

Mr. J. E. Smith, President, Dept. 3MP3
NATIONAL RADIO INSTITUTE, Washington 9, D. C.

Mail me FREE, without obligation, your Sample Lesson and 64 page book "Win Rich Rewards in Radio." (No salesman will call. Please write plainly.)

Name _____ Age _____

Address _____

City _____ State _____ 4FR

TRAINING MEN FOR VITAL RADIO JOBS

GOOD PAY

Strange Keys to the Powers of the Universe

"GOD GEOMETRIZES," said an ancient sage. Within the straight line, curve, and angle—and their combinations—exist the forces of creation. These *secret symbols* contain the mysterious laws of the universe. Upon their right use—or the neglect of them—the success or failure of every *human enterprise* depends.

Have you a desire, *something you wish to accomplish* in life? Put your finger on a dot. In whatever direction you move your finger from the dot, you have made a beginning. Thus a dot is the symbol of *one*—or a beginning. Your desire then is also symbolized by *one*. If you follow the *proper method* or way to accomplish what you want, you have arrived at point *two*. Whenever these two symbols are brought together—the idea and the right way—you produce point *three*—the success of your plan. Success, therefore, is symbolized by the three equal sides of a *triangle*.

In planning your personal affairs—business, domestic, or the welfare of your family—do you use a *Cosmic formula?* Do you determine whether your acts are in accord with Divine truths eternally expressed in *symbols?* Why does the circle represent completion? Why is it said that a man is on the square? These symbols are used by astronomers and scientists to prove the physical laws of the universe—why don't you apply them to the problems of your everyday world? Learn what *symbols*, as powers and forces of nature, you can amply and intelligently use in directing the course of your life.

Let the Rosicrucians (not a religious organization), a world-wide brotherhood of learning, reveal to you *the symbolism of successful living*.

Let this GIFT BOOK Explain

If you want to prepare yourself through understanding for the greater rewards of life, write for the fascinating *free* Sealed Book. It explains how you may receive this age-old wisdom. Use the coupon below.

Scribe Y. A. K.
THE ROSICRUCIANS, AMORC
San Jose, California, U. S. A.

Please send me the Free, Sealed Book. I am interested in knowing how I may obtain the masterful Rosicrucian teachings.

Name .....

Address .....

.....

THE ROSICRUCIANS, AMORC - SAN JOSE, CALIFORNIA, U. S. A.

15 Minutes a Day!

Give me just this and I'll prove I can make you

A NEW MAN!

Charles Atlas

—actual photo of the man who holds the title, "The World's Most Perfectly Developed Man."

I'M "trading-in" old bodies for new! I'm taking men who know that the condition of their arms, shoulders, chests and legs—their strength, "wind," and endurance—is not 100%. And I'm making NEW MEN of them. *Right now* I'm even training hundreds of soldiers and sailors who KNOW they've got to get into shape FAST!

Only 15 Minutes a Day!

Are you ALL MAN—tough-muscled, on your toes every minute, with all the up-and-at-'em that can lick your weight in wildcats? *Or do you need the help I can give you*—the help that has already worked such wonders for other fellows, everywhere?

All the world knows I was ONCE a skinny, scrawny 97-lb. weakling. And NOW it knows that I am the holder of the title, "The World's Most Perfectly Developed Man." How did I do it? How do I work miracles with the bodies of other men in only 15 minutes a day? The answer is *"Dynamic Tension,"* the amazing method I discovered and which changed me from a 97-pound weakling into the champion you see here!

In just 15 minutes a day right in the privacy of your own home I'm ready to prove that *"Dynamic Tension"* can lay a new outfit of solid muscle over every inch of your body. Let me put new, smashing power into your arms and shoulders—give you an armor-shield of stomach muscle—strengthen your legs into real columns of surging stamina. If lack of exercise or wrong living has weakened you *inside*, I'll get after that condition, too, and show you how it feels to LIVE!

Charles Atlas—America's Greatest "Builder of Men"

Among all the physical instructors and "conditioners of men" ONLY ONE NAME STANDS OUT. That name is Charles Atlas!

In every part of the country Charles Atlas is recognized as "America's Greatest Builder of Men." Thousands upon thousands have put their physical development into his capable hands!

And now that the call is for men capable of helping America meet and conquer any national emergency, many thousands of others (even those already in their country's Army and Navy) are calling upon Charles Atlas to build the kind of men America vitally needs!

MAIL THIS COUPON NOW!

FREE ***This Famous Book that Tells You How to Get a Body that Men Respect and Women Admire***

My book, *"Everlasting Health and Strength,"* tells you exactly what *"Dynamic Tension"* can do. And it's packed with pictures that SHOW you what it does. RESULTS it has produced for other men. RESULTS I want to prove it can get for YOU! If you want to learn how you can actually become a NEW MAN, right in the privacy of your own home and in only 15 minutes a day, then man!—get this coupon into the mail to me as fast as your legs can get to the letterbox! CHARLES ATLAS, Dept. 111, 115 East 23rd St., New York 10, N. Y.

CHARLES ATLAS, Dept. 111
115 East 23rd St., New York 10, N. Y.

I want the proof that your system of *"Dynamic Tension"* will help make a New Man of me—give me a healthy, husky body and big muscular development. Send me your free book, *"Everlasting Health and Strength."*

Name .....
(Please print or write plainly)

Address .....

City ..... State .....

☐ Check here if under 16 for Booklet A.

More GOOD JOBS in DRAFTING

in AIRCRAFT and other War Industries!

Calls for Draftsmen Are Increasing! . . . Read the want-ads for proof of this urgent demand.

This complete drawing outfit,—everything to work with,—including drafting table, drawing board, supplies, etc., —ALL SENT TO YOU AT NO EXTRA COST if you are a Chicago Tech Student.

Mail Coupon Below

The War Production program has increased the demand for Aircraft Draftsmen Machine Draftsmen, Architectural Draftsmen, Electrical Draftsmen, and Structural Draftsmen. The Draftsman always comes first on any new project in manufacturing and industry—peace or wartime.

The Draftsman—"The Key Man" in War or Peacetime Industry

No new machines can be built, no airplanes constructed, no bridges or buildings erected, no ships or submarines launched until the draftsman has completed his work. Real immediate opportunities exist in Drafting—the profession upon which all construction is vitally dependent Drafting is clean, interesting, well paid work. Steady employment. Investigate today what Drafting offers you! Help your country in a vital War production job on the important Home Front—and help yourself to a well paid job in Drafting

Learn in Spare Time,—at Home!

(or at the College in Chicago)

With our easy step-by-step lessons, (and the tools we furnish), you can learn in your spare time at home. Convenient terms. To prove to you how easy it is to learn Drafting by the Chicago Tech Method we'll send you a Trial Lesson FREE. No charge for this lesson either now or later. Send a post card or the coupon now for

free

TRIAL LESSON

Send Coupon

CHICAGO TECHNICAL COLLEGE

P-219 Tech. Bldg., 2000 S. Michigan Ave., Chicago 16, Ill.

Yes,—please send me *FREE Trial Lesson in DRAFTING*

- ☐ Aircraft Drafting
- ☐ Electrical Drafting
- ☐ Architectural Drafting
- ☐ Machine Drafting
- ☐ Structural Drafting
- ☐ Building Construction

Name.....

Address.....

City..... State.....

Occupation..... Age.....

AVIATION

FOR YOUR CAREER PLUS WAR SERVICE

Both

AT THE SAME TIME

Before you are 18 MAKE YOURSELF THE KIND OF MAN THE AVIATION INDUSTRY OR THE AIR SERVICES WANT . . THE KIND THEY CANNOT DO WITHOUT . . so you can ADVANCE RAPIDLY Since 1929, Curtiss Wright Tech has been specializing in modern and progressive training for Aeronautical Engineers and Master Aviation Mechanics No flying involved! Write for full information. Include name, address and date of birth. Dept. PS-11

CURTISS WRIGHT TECHNICAL INSTITUTE

GRAND CENTRAL AIR TERMINAL
Glendale (Los Angeles Co.) California

WAR OPPORTUNITIES for *YOU* in ACCOUNTING

War needs call for many new bookkeepers and accountants at good pay. Taxes and government regulations demand many extra in government offices and in industry. Enlarged plants need more. Also, many present accountants are being called to the armed services. This opens unusual opportunity to women and to men not subject to military call. And this opportunity will continue after the war is over.

You can prepare for these opportunities in spare time at home Cost is moderate and easy terms can be arranged For 34 years LaSalle has been training accountants—over 2,000 C.P.A.'s among our alumni. Our training is condensed, practical, interesting Instruction staff of full-time C.P.A.'s. You can take short course or full accountancy course. Free placement service.

Write today for free 48-page booklet, "Accountancy, the Profession That Pays." It describes the opportunities and requirements of this field and tells of our training.

Please send me your free booklet, "Accountancy, the Profession That Pays," and information about your training.

Name..... Age.....

Address.....

City and State.....

LASALLE EXTENSION UNIVERSITY
A Correspondence Institution
Dept. 1183-H CHICAGO, ILL.

INVENTORS

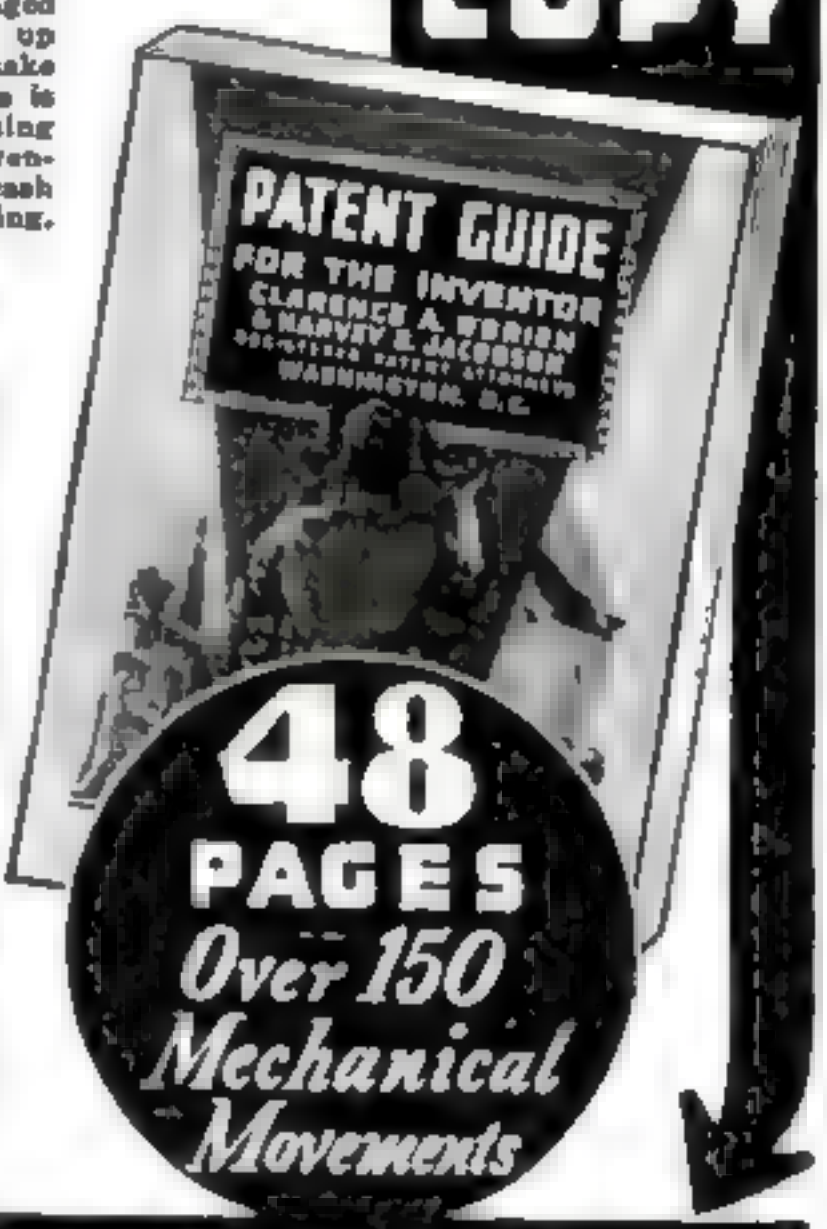
Get FREE COPY

NOW Is the Time to PATENT and SELL Your Invention

Now, more than ever before, is the right time to patent your invention. Why? Because manufacturers everywhere presently engaged in war production are looking ahead to the future by buying up patent rights now, so they will have new and attractive items to make and sell for civilian consumption as soon as the war is over. This is what happened during and after the last war. Hence, the smart thing for you to do is to look ahead to the future too. Protect your invention by applying for a patent now, so you will be in position to cash in on an outright sale, or on the royalties your invention will bring.

Patent Guide Shows What To Do

Our "Patent Guide for the Inventor" answers many important questions concerning Patents that inventors constantly ask. It tells what facts, details, drawings, sketches, etc. are necessary to apply for a Patent; how to protect your invention through dated and witnessed disclosure; how to do this AT ONCE to safeguard your rights; how Patent Office Records can be checked to determine whether the invention is probably patentable before filing fees need be paid; discusses costs involved and a practical way these can be paid as the application progresses. It tells how some inventors secured financial backing, how many simple inventions have proved large commercial successes, how Patents covering improvements also can be profitably utilized and marketed; tells countless other facts of interest.



Why You Need Expert Assistance

The Patent Laws were enacted for your benefit—to give you protection for the features of your invention which are Patentable. But these features must be legally and concisely set forth in the form of "claims." This phase of the procedure is so complex that the Patent Office advises the Inventor to engage a competent Registered Patent Attorney. We maintain a large staff—carefully trained registered patent attorneys—expert draftsmen—experienced searchers—to serve you. We have been serving inventors for more than 20 years.

Take First Step Now

With the Patent Guide you will receive also Free a "Record of Invention" form which will enable you at once to establish the date of your invention, before you file your Patent application. This step costs you nothing yet may be vital to your success. Remember—in Patent Matters, ACTION is IMPORTANT. Delay can be costly. Mail the coupon in an envelope, or paste it on a penny postcard NOW.

CLARENCE A. O'BRIEN & HARVEY B. JACOBSON

"Worthy of your Trust"

Registered Patent Attorneys

32-L Adams Building

Washington, D. C.

Get This FREE BOOK

IMMEDIATELY MAIL COUPON TODAY!

CLARENCE A. O'BRIEN & HARVEY B. JACOBSON

CLARENCE A. O'BRIEN & HARVEY B. JACOBSON
Registered Patent Attorneys before the United States Patent Office
32-L Adams Building, Washington, D. C.

Please send me your 48-Page "Patent Guide for the Inventor" and your specially prepared "Record of Invention" form FREE. This request does not obligate me.

Name _____

Address _____

City _____ State _____

(Please write or print plainly.)

Readers Say:

Sailors Had an Easier Way of Doing It in 1897

ON PAGE 72 of your August issue, you give a vision-range formula that has been worked out by the Clipper captains of Pan American Airways. The formula is to multiply the square root of the plane's altitude by 1.225, the result being the distance that a pilot can see. Some time around 1897 I read an engineering handbook that said something to this effect: "Any intelligent officer of a ship knows that the square root of 1.5 multiplied by the height of the eye in feet is the distance of the visible horizon." I have experimented with both formulas, and I find that they give approximately the same results—only I think that the older one is easier to work with and to remember. I've remembered it for over 40 years.—W. H., Cranbrook, B. C., Canada.

Perhaps Recent Jap Reverses Are Responsible

THE LETTER of M. L. H., of Levering, Mich., in the September issue, may have been intended as a humorous contribution to your Readers Say columns, but it does not alter the fact that water that is allowed to drain undisturbed from a bathtub or similar container, will always swirl counterclockwise. Naturally, if a person puts his hand in the swirl and swings it around clockwise, he can reverse the direction of the swirl. Incidentally, here is a question I would like to put to M. L. H. If he should ever travel south of the Equator—in the South Pacific area, for example—he will find that draining water always swirls clockwise. Perhaps he can tell me why?—G. E. B., Niagara Falls, N. Y.

Hearty Approval of P.S.M.'s Two-Purpose Back Cover

HAS ANYONE ever complimented you on your back cover, which makes such a handy marker for reading? If no one has, allow me to. I find it a special convenience, and sincerely hope that you have no intention of discontinuing this feature. I have been taking POPULAR SCIENCE for more years than I care to remember. I start at the front cover and plow straight through it. I invariably enjoy every issue.—G. M., Dover, Fla.

A Good Steer—Straight from the Manufacturer

THE ARTICLE on page 129 of your September issue covering the adjustment of our automobile steering gear was naturally of great interest to us. We should like to point out, however, that to eliminate end play in the roller shaft of the Gemmer gear, the adjustment should be made with the steering wheel in mid position, as when driving straight ahead. The design of the Gemmer gear is such as to permit adjustment for wear in the center of the worm without causing binding either side of the center. If adjustment is made either side of center, however, the gear may bind in the mid position. Any backlash at either end will cause no trouble because the gears are under thrust when in the turning position.—G. B., Gemmer Manufacturing Co., Detroit, Mich.

A Torpedoed Midshipman Gets Us Right Side Up

WHILE reading through the July issue, I noticed in your article, "These Are the Badges of Courage," that your photograph of the three-striped Torpedoed Seaman Bar is upside down. The light blue stripe, representing the sky, should be at the top, and the dark blue stripe, representing the water, should be at the bottom. The red stripe in the middle stands for the action encountered. I've checked this carefully so that I am pretty sure that I've got it right. At any rate, that is the way I wear the one that was issued to me.—Cadet Midshipman W. A. P., U. S. Merchant Marine Academy, Kings Point, L. I., N. Y.

You're perfectly right, W. A. P.—and thanks. All we can say is that we're glad we at least got the red stripe in the right place.—Ed.

You can't see it . . . but it's there

THE MOST ACCURATELY machined rotating part ever built—although apparently in balance to the naked eye—may be *out of balance.*

You can't see the unbalance . . . even if it's there.

With the rapid development of high-speed machines, the need for *locating and correcting* unbalance in rotating parts has become vitally important—if you want smooth, vibration-free operation and long life.

In 1933, scientists in the Westinghouse Research Laboratories tackled this problem of quickly and accurately measuring the *static* and *dynamic unbalance* in rapidly whirling masses—both symmetric and asymmetric.

Through painstaking study and experiment, these Westinghouse research engineers discovered a totally new principle for balancing rotating parts of every shape and form . . . the "Dynetric Balancer."

Today, the Gisholt Dynetric Balancer . . . using Westinghouse *electronic equipment* . . . is solving the most difficult balancing problems in many war plants.

With this machine, vibrations as small as *twenty five millionths* of an inch in crankshafts, armatures, turbine rotors, propellers, and countless other whirling parts are located and measured in a matter of minutes, or even seconds!

Westinghouse Electric & Manufacturing Co., Pittsburgh, Pennsylvania.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Readers Say:

A Lost Poem Finds Its Author

I HAVE just noticed in your "Readers Say" for July a letter from Captain A. R., of the Royal Canadian Air Force, Lachine, Quebec, concerning the poem, "A Gunner's Vow," which appeared on page 118 of your April issue. The captain is quite right about the author's initials being G. H. H. The author's full name is George Henry Harding—and I'm very proud to be able to tell you that he is my son. He wrote the poem in August, 1940, at the time he was training to be an air gunner. He was later made a pilot and then grounded because of airsickness. He is now a radio operator in the R.C.A.F. The poem, as it appears in your April issue, is incomplete. It has a first stanza which goes as follows:

If I must be a gunner,
Then please Lord grant me grace,
That I may leave this station
With a smile upon my face.

I am quoting this first stanza for you with the thought that those of your readers who enjoyed the poem as it appeared in your magazine, and who possibly have made copies of it, might like to have the poem in its entirety.—Mrs. G. H., London, Ont., Canada.

Five Sons Keep Ma Hep to Jeeps

WHEN the war is over we shall see the jeep doing more work in civilian life than it did in the service. It is bound to be a vital machine on farms, in logging camps, in oil fields, and in mining districts. In metropolitan areas it will be every busy business man's first aid to success. P.S. I have seven sons—five in the armed forces, and two about to enter. That's why I know so much about jeeps.—Mrs. W. M. F., Cleburne, Tex.

We Fielded This One Without an Error

IN THE article, "Big Leagues Get a War Baseball," which appeared in your July issue, you state that A. G. Spalding & Bros., make all the baseballs used in the major leagues. Yet in the photograph in the lower right-hand corner of page 47 you show a National League ball with Spalding's trademark and an American League ball with Reach's trademark. How about that?—B. B., Greensboro, N. C.

Very simple, B. B — Spalding uses two trademarks: one for the National League, one for the American. The balls are identical —with, of course, the exception of the trademark.—Ed.

We Didn't Mean to Be So Tough on Boules

IN LOOKING over the January issue of your magazine, I noticed in your article entitled "Synthetic Jewels," that you have given the Mohs hardness of aluminum oxide boules as 9.3. As director of research for a company engaged in the manufacture of abrasives and refractory materials, I have reason to believe that this figure is incorrect. I know that the boules are hard, but I don't think they are quite that hard.—R. C. B., Niagara Falls, N. Y.

You're right, R. C. B. The figure should be 9.03. Thank you for calling the error to our attention.—Ed.

For Old X-Ray Negatives —Alcohol in Moderation

IF J. A. K., of Nashville, Tenn., whose letter appeared in your August issue, will wipe his old X-ray negatives with a cloth that has been dampened with ordinary "rubbing" alcohol, he will find that this thoroughly cleans the film. He must be careful, however, not to douse the cloth too heavily with alcohol, else the gelatine base is likely to become mushy.—T. J. L., Minneapolis, Minn.

Heroes' Alma Mater

Our airmen have proved themselves masters of anything that flies.

When you hear of their exploits you wonder how such skill, such devastating dexterity could be acquired in a few brief months. Surely, these men must have been "born to the blue."

Yet the plain fact is that scarcely one in a thousand ever flew a plane before the war. Each and every one had to be *trained*—thoroughly and quickly.

In their training, the Fairchild PT 19 Primary Trainer with "fighter" characteristics is their flying school.

This staunch little ship is ideal for the rigorous acrobatic program prescribed in primary training. In the words of a veteran pilot-teacher now at an Army flying school: "It is unnecessary to caution a student or to warn him about excessive speeds in pull-outs or dangerous positions while he is flying a PT-19. We simply go ahead and teach him to do every maneuver in the book: slow rolls, snap rolls, Immelmanns, loops, half rolls, inverted coordination exercises and turns, vertical reversements, spins, and combinations of these. The PT-19 can certainly 'take it.' That is the best confidence builder ever invented."

From behind soda fountain and plow, office desk and ivied walls, after a short intensive training in the PT-19, the most daring and expert flyers the world has known have emerged. After six hours training in a PT-19 it is not unusual to solo Army students who have never flown before.

As a constant check on the performance of PT-19's, on the American mainland and abroad, the reports of a corps of specialists written in the field, enable our engineers and designers back home to keep that "touch of tomorrow in the planes of today."

Free 7-Day Offer!

AUTO MECHANICS!

REPAIR ANY MAKE CAR— TODAY!

Explains Every Repair Job on Every Model of All These Cars—1935 through 1942

American Bantam; Auburn Austin Buick; Cadillac; Chevrolet; Chrysler; Cord; DeSoto Dodge; Ford; Graham Hudson Hupmobile Lafayette; LaSalle Lincoln Lincoln Zephyr Mercury; Nash Oldsmobile; Overland; Packard; Pierce Arrow; Plymouth; Pontiac Reo Studebaker; Terraplane Willys

200 000 Facts 480 Charts 900 Photos, Drawings, Diagrams. Size 8¼x11 in. Published by MoToR, The Leading Automotive Business Magazine.

Helps EVERY Mechanic—even experts—do repair jobs easier, quicker

Explains every auto repair operation STEP-BY-STEP. Easy-to-use! Hundreds of photographs, diagrams, drawings, show exact "how to do it" of repairs, adjustments, replacements. *All* jobs on *every* model since 1935! Engine; Electric, Fuel, Cooling, Lubrication Systems. Clutch, Transmission, Universals Rear End; Wheels, Brakes; Knee Action, Shock Absorbers, Springs; Body; Free Wheel, Overdrive, Fluid Coupling!

ISO FACTORY BOOKS IN ONE!

Imagine a COMPLETE COLLECTION of ALL official shop procedure manuals, prepared by each car manufacturer's own engineers! That's what you GET in this book! Open the manual to the car you want—you'll find everything to show the *right* way to do the job. This is the factory shop manual used by the U. S. Army, trade, technical and vocational schools.

SEND NO MONEY

Simply fill out coupon below. Mail it today and a copy of MoToR's up-to-the-minute New Auto Repair Manual will be sent to you at once for 7 days Free Examination.

Same FREE 7-Day Offer! MoToR's Truck Repair Manual

1400 pictures, 905 pages, 300,000 facts. Used by U. S. Armed Forces. Strong Fabrikoid binding, size 8½x11. Covers 10,000 models 1936 1942. All Gasoline Engines. ALL DIESELS. Hessel-man Diesel Fuel Injection Systems, etc., etc.

MoToR Book Dept., Desk 2211, 572 Madison Ave., New York 22, N. Y.
Rush to me at once: (check box opposite book you want).

☐ **MoToR's AUTO REPAIR MANUAL** *(formerly "MoToR's Factory Shop Manual").* If O.K. I will remit $1 in 7 days, $1 monthly for 4 months, plus 35c postage with final payment ($5.35 in all) Or I'll return book in 7 days. **(Foreign, remit $7 with order.)**

☐ **MoToR's TRUCK REPAIR MANUAL.** If O.K., I will remit $2 in 7 days, $2 monthly for 3 months, plus 35c postage with final payment ($8.35 in all). Or I'll return book in 7 days. **(Foreign, remit $11 with order.)**

Name _____ Age _____

Address _____

City _____ State _____

☐ Check here if enclosing full payment. WE pay 35c postage. Same 7-Day Return Privilege.

HOW I STEPPED *into a* Big Pay HOTEL JOB!

Knew Nothing About Hotel Work, R. W. Hedges Becomes Hotel Manager With Substantial Increase In Salary

"Dissatisfied with my job in an oil company, I enrolled for the Lewis Course. Soon after completing my training I was appointed Catering Manager of an Omaha hotel. Then the Lewis Employment Bureau placed me as Kitchen Steward of another hotel. I made constant progress, finally stepping from an Assistant Managership to my present position as Manager of this new 250 room hotel at a substantial salary increase. I owe my success to Lewis Spare-Time, Home Study Training."

HOTELS NEED TRAINED MEN AND WOMEN

Thousands of Lewis-trained men and women winning success in the colorful, essential hotel, club and institutional field. They are making good as Managers, Assistant Managers, Stewards Hostesses Executive Housekeepers and 55 other types of well-paid positions. Today our Government's vast wartime housing, food and recreational program swells the demand for trained men and women. Opportunities for Lewis graduates greater than ever; their success has proved previous experience unnecessary in this business where you are not overpaid because you're over 40. Good grade school education plus Lewis Training qualifies you at home in spare time. Write your name and address in the margin and mail this ad TODAY for Free Book which tells how you are registered free of extra cost in Lewis National Placement Service.

"I'm A Success At 52"

For 7 years I had been with a big electric company. Not satisfied with the salary and opportunities, I enrolled for Lewis Training. They placed me in my best position as Housekeeper of a famous resort hotel. Now Hostess-Housekeeper at this beautiful apartment hotel. — Alice Barton

LEWIS HOTEL TRAINING SCHOOL
Room 8X-2705 Washington 7, D. C.
(28th Year)

EVERY Musician SHOULD GET THIS BOOK!

Your band instrument must last for the duration. That's why you need this new and helpful book, How To Care For Your Instrument. In no other book can you find such valuable and helpful information. Covers all makes and types of wind and percussion instruments. 40 pages of instructions, 46 illustrations to help make your instrument last longer. Worth many times its 10c cost. Get yours at your Conn dealer's or send 10c today.

ONLY 10¢ WORTH FAR MORE

C. G. CONN, Ltd., 1152 CONN BLDG., ELKHART, IND.

Send me ___ copies of "How To Care For Your Instrument." Enclosed find ___ in coin or stamps (___ each).

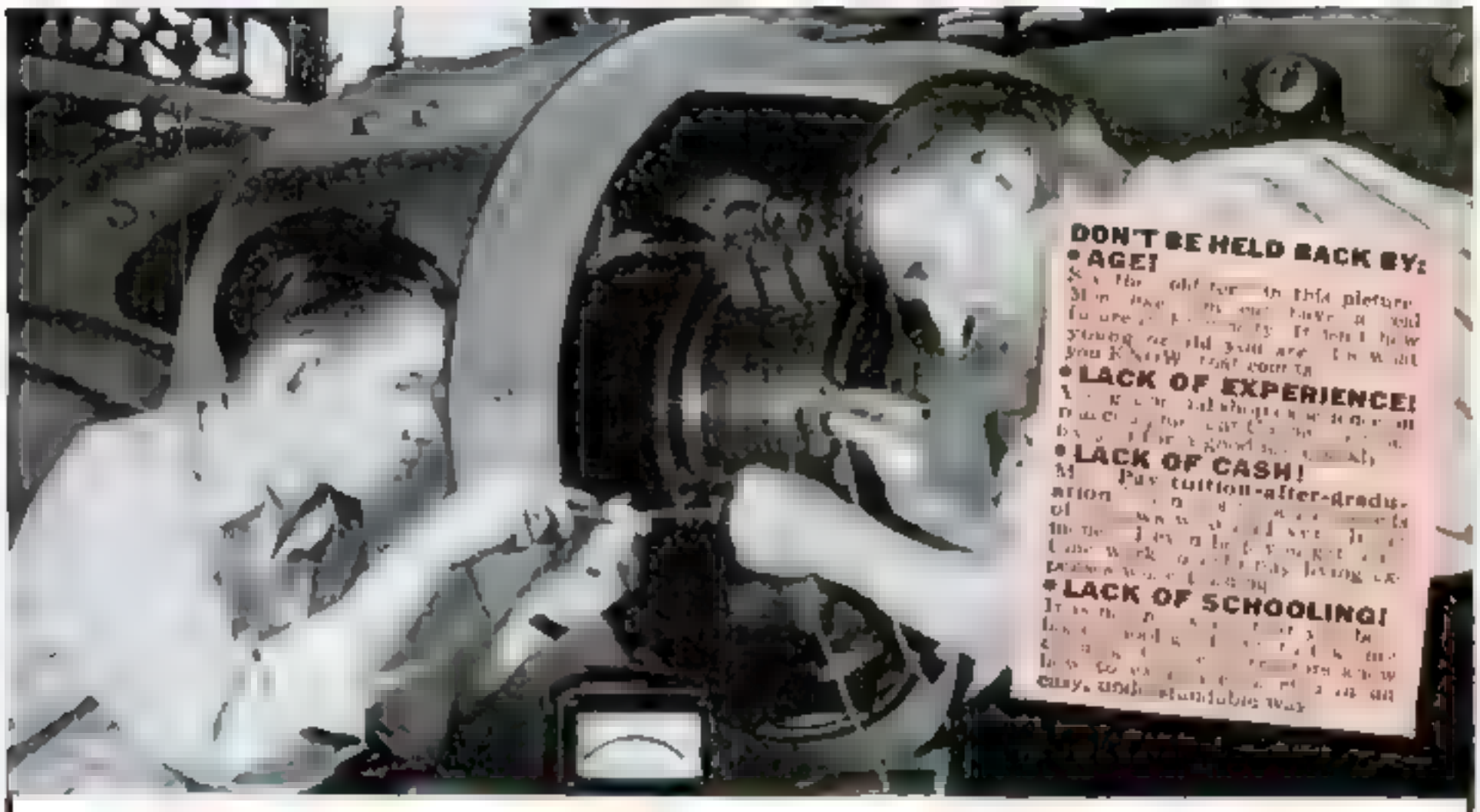
NAME _____

ADDRESS _____

CITY _____ STATE _____

MEN! Learn ELECTRICITY whether you are 16 OR UP TO 50

GET THE TRAINING YOU NEED IN 12 WEEKS AT COYNE



Do VITAL WAR WORK...with a VICTORY FUTURE!

I'LL FINANCE YOUR TRAINING!

Don't wait to be assigned to some dull, low-pay no-future job. Get your training at Coyne NOW — and be ready soon to take your pick of many well-paid electrical positions.

Learn to do more vital work for America's war program. In 12 short, busy weeks in the Coyne Shops you can get the "know-how" you need for a real opportunity now — and at the same time you'll be in a field with a peace-time future.

Learn-by-Doing on Real Equipment

Coyne has a vast amount of floor space in shops where you learn on motors, switchboards, electronic devices, air conditioning and refrigerating apparatus, auto and aircraft engines. You also learn house wiring, motor winding, armature winding, etc., etc.

You don't need previous experience or advanced education. You train by actual work. In 90 days at Coyne you can master this training and be ready for a good job—a COYNE-TRAINED ELECTRICIAN!

START NOW—PAY LATER!

Lots of fellows who come to Coyne have very little cash. So don't delay for that reason. I'll finance your training. I'll help you get part-time work to help pay living expenses while in school. You can pay tuition in easy monthly payments AFTER YOU GRADUATE.

JOB SERVICE FOR LIFE

As soon as you're trained, my Graduate Employment Service will assist you in getting located. This service is FREE to graduates. We have placed many in fine jobs all over America. You'll find this service a big help now and throughout your lifetime.

GET MY BIG FREE BOOK!

See what Coyne offers. My big book of pictures, facts and PROOF is yours on request. Clip and mail coupon at once. Learn how quickly and easily you can become a COYNE TRAINED ELECTRICIAN. Your opportunity is waiting. Send for my big book TODAY.

H. C. LEWIS, President
COYNE ELECTRICAL SCHOOL
500 So. Paulina St. Dept. 83-73 Chicago, Ill.

New Opportunity Offer!

EXTRA COURSE IN
RADIO AND ELECTRONICS INCLUDED!

Electricity is the foundation of all Radio, Television and Electronics. When you combine your Coyne electrical training with my new special Radio and Electronics course, you have the basis for a great future in this sensational, fast-growing field.

44 YEARS OF SUCCESS — AMERICA'S PIONEER "LEARN-BY-DOING" SCHOOL

H. C. LEWIS, President
COYNE ELECTRICAL SCHOOL
500 S. Paulina Street, Dept. 83-73, Chicago, Ill.
Send me your Free Book. Tell me about your Special Radio & Electronics Training and Part Tuition after Graduation offer.

NAME .....

ADDRESS .....

CITY ..... STATE .....

INVENTORS

This BOOK

and INVENTION RECORD (Cost You Nothing) FREE BOOK

HOW TO PROTECT, FINANCE and SELL YOUR INVENTION

Our FREE BOOK and other literature available to our clients gives you complete data on how to "ready" your invention for money making. It tells you how others did it—who they went to for finances—how they arranged partnerships—how they made contacts with manufacturers—how they dictated royalty arrangements—how much money they made—how you can find a market. Our new FREE BOOK discusses sources of quick revenue if your invention is patentable and saleable with profit possibilities.

THE FIRST STEP

The first step in getting your invention ready for market is to make a dated record of it on our "Invention Record" Form. This form properly filled out and witnessed will be invaluable to you later in establishing the date of your invention should need for such evidence arise. We will be glad to send you our "Invention Record" and have it witnessed in this office when you return it with disclosure of your device. This service costs you nothing—and it immediately puts you on record as the originator of your device.

Protect Your Invention NOW!

We have many letters in our files from manufacturers requesting inventions. Today's demand for new devices is tremendous—added to by emergency needs. Protect your invention now with a U. S. Patent. By acting promptly you may prevent another inventor getting ahead of you at the Patent Office here in Washington. The first step is to make a sketch and description of your invention on our "Invention Record"—have it witnessed and mail it to us. We will then make a Search of the U. S. Patent Office files to ascertain whether we can get patent protection for you. This is a step you should make NOW—before another steps in ahead of you and walks away with a patent.

COUPON TODAY

McMORROW & BERMAN

PATENT ATTORNEYS

142-L Albee Building, Washington 5, D. C.

Send me your NEW FREE Book "How to Protect, Finance and Sell Your Invention" and specially prepared "Invention Record" form at once. I understand that this request does not obligate me.

NAME.....

ADDRESS.....

CITY..... STATE.....

Write or Print Name Clearly

M-J

IT'S FREE!

Don't Miss This up-to-the-minute

NEW BOOK

THE PORTER CHEMICAL CO., 44 PROSPECT AVE., HAGERSTOWN, MD.

SUPER JU JITSU

NOW GET TOUGH DOUBLE-QUICK!

Learn how YOU can be dangerous. Lick brutes twice your size *with only your bare hands*, even when they are armed. This powerful fighting system is unbelievably efficient. You don't need ox like muscles — it's brains that count! New, easy self-study course at **amazing low price**. Free trial offer and money-back guarantee. Hurry! Write today for FREE DETAILS. Nelson Co., 4215 Wabash, Dept. L-503, Chicago.

Try Anti-Gray Hair Vitamins

Plus Wheat Germ Oil (E) Vitamins ON THIS MONEY BACK OFFER

RESTORING COLOR TO GRAY HAIR WITHOUT DYES IS SCIENCE'S LATEST MIRACLE

If your hair is gray, graying or streaked, faded or off color, modern science offers new hope without dyeing. A lack of certain vitamins in your daily diet can cause hair to turn gray. Impatient? You don't get extra vitamins of these kinds from pills. Instead, by simply taking the original 2 way Panates Vitamin treatment. You may be amazed and delighted to see the gray start to disappear, restore color to normal parts of hair to blend in. Dandruff, dry scalp, itching, parting, a great improvement in your hair's beauty. You can now test Panates yourself on an iron clad guarantee that leaves no room for doubt.

PANATES is different—it not only contains a powerful supply of Anti-Gray Hair Vitamins but "Staff-of-Life" Vitamin (E) Wheat Germ Oil as well. Panates is not a quick dye. You have nothing to fear. No messy dyes. You can test safe, healthful Panates whether you have dyed your hair or not, because Panates Vitamins work from within to check gray spread and literally feed natural color back into the hair roots.

When the blood does not provide the proper elements the (tiny) laboratories that manufacture your color shuts down and the hair grows gray. Perhaps you may need the vitamins in Panates. Make this test today.

SEND FOR THIS INTRODUCTORY TRIAL OFFER TODAY

The 30 day trial of the regular $4.75 (40 day) Panates double action Vitamins is only $1.79. If you act at once! **SEND NO MONEY** pay postman plus C.O.D. postage on arrival on guarantee of full satisfaction or money back. Send $1.79 and we pay all postage. Or if you want more of the amazing Panates Anti-Gray Hair Vitamin story, write for **FREE Valuable Booklet, "Vitamins and Gray Hair."** No cost, no obligation. Whatever you send for, put your letter or postcard in the mail today while Special Offer is available. Who knows perhaps the 2 vitamins in Panates may be the wonderful easy way answer to your hair color worries!

PANATES CO.

Not in stores. Write

Dept. A-262, 310 S. MICHIGAN AVENUE, CHICAGO 4, ILLINOIS

AUDELS AIRCRAFT WORKER.... $1

Answers Your Questions on 1—Aircraft Materials, Terms, Parts 2—Blueprints, Working Drawings. 3—Mathematics, how to figure. 4—Layout & Bending. 5—Tools & Machines. 6—Riveting Spot Welding & Hints. 7—Fabrication, Angles, etc. 8—Assembly. Fuselage, Wing & Final—How to Use Tools. 9—Tables & Data. Symbols, Army & Navy Specifications, etc. 248 Pages Illus.

AUDELS SHEETMETAL PATTERN LAYOUTS.....$4

Developed by Experts for Sheet Metal Workers, Layout Men & Mechanics. A Practical Easy operating 10 Sections, size 7 x 10 x 2—1125 Pages—1100 Layouts—1000 Illustrations 1091 Key Parts. Fully indexed for ready reference to answer the many layout problems. Covers all phases of sheet metal work including Pattern cutting. Pattern Development & Shop Practice.

AUDELS SHEETMETAL WORKERS HANDY BOOK.....$1

Practical Inside Information. Fundamentals of Sheet Metal Work 348 pages. Illustrated. 11 sections. Clearly written. Essential & important facts, figures, pointers in every day Language. Ref. Index.

AUDELS WELDERS GUIDE.....$1

A concise, practical text on operation & maintenance of all welding machines for all mechanics. Over 400 pages, illustrated. Covers all methods of electric and acetylene welding including airplane work.

AUDELS ANSWERS ON BLUE PRINT READING.....$2

For Mechanics & Builders. Covers all types of blue print reading including ship & airplane. 316 pages, fully illustrated.

AUDELS NEW MACHINIST & TOOLMAKERS HANDY BOOK...$4

Covers modern machine shop practice in all its branches. 3 practical books in 1. New from cover to cover. Tells how to set up & operate lathes, screw and automatic machines, shapers, & all precision and all other machine tools. 1600 pages fully illustrated. 7 x 9 x 2 Indexed. 5 sections. 1—Modern Machine Shop Practice. 2—Blue Print Reading & How to Draw. 3—Calculations & Mathematics for Machinists. 4—Shop Physics. 5—How to Use the Slide Rule. 60 chapters. Easy to read and understand. A shop companion that answers your questions.

AUDELS MATHEMATICS & CALCULATIONS FOR MECHANICS $2

Mathematics for home study or reference. 540 pages, 300 Illus. Practical mathematics from beginning. How to figure correctly. Easy, correct methods covering a complete review. Illustrated.

AUDELS AUTOMOBILE GUIDE..$4

A practical quick ready reference book for auto mechanics, service men, operators & owners. Explains theory, construction & servicing of modern motor cars, trucks, buses & auto type Diesel engines. 1600 pages, fully illustrated. 55 chapters. Indexed. A standard book for mechanics. New 6th Edition revised.

AUDELS DIESEL ENGINE MANUAL $2

A practical, concise treatise with questions and answers on the theory, operation and maintenance of modern diesel engines including General Motors 2 cycle & 4 cycle. 1344 pages, fully illustrated, flexible binding, pocket size. All latest practice brought out. This book is of extreme value to engineers, operators & students.

AUDELS RADIOMANS GUIDE $4

A key to the practical understanding of radio including Frequency Modulation, Television, etc. A recent & Marine Radio Receiving sets, servicemen, amateurs. 752 pages, 600 illustrations & Diagrams. Photos. Review Questions & Answers. Reference Index. Authentic, clear, concise.

AUDELS HANDY BOOK OF PRACTICAL ELECTRICITY $4

For maintenance engineers, electricians & all electrical workers. 1410 Pages, 2000 Illus. Covers important electrical information in handy form—including Marine Wiring, Radio Telegraphy, Welding. Indexed. A key to a practical understanding of electricity.

AUDELS CARPENTERS & BUILDERS GUIDES—4 Vols. $6

A practical illustrated trade assistant on modern construction for carpenters, joiners, builders, mechanics and all woodworkers. 4 vols., 1600 pages, 3000 illustrations, durable covers. Each volume pocket size. Sold separately $1.50 a vol.

AUDELS PLUMBERS & STEAMFITTERS GUIDES—4 Vols. $6

A Practical Trade Assistant & Ready Reference. Explains in plain language & by clear illustrations, diagrams, charts, graphs, pictures principles of modern plumbing practice including Marine Pipe Fitting and Air Conditioning. 4 Vols.—1670 Pages—1200 Diagrams. Each Vol. Pocket Size. Sold Separately $1.50 a Vol.

AUDELS WIRING DIAGRAMS.....$1

219 Pages. Illustrated. Gives practical facts on wiring of electrical apparatus. It explains clearly in simple language how to wire apparatus for practically all kinds of electricity. Each diagram is complete & self-explanatory. Highly Endorsed Pocket Companion.

AUDELS ELECTRONIC DEVICES...$2

Tells What You Want to Know About Electric Eye. Easily Understood. Covers photo-electric cells & their applications. Amplifiers, illumination, frequencies, voltage, photocell, tubes, Ohm's Law, wiring diagrams, etc.

AUDEL, Publishers, 49 W. 23 St., N. Y. 10

AN AUDEL GUIDE IS A GOOD FRIEND!

Use the brains and experience of others in these Guides of the Trades. Save time and money with right methods, short cuts, labor saving ideas. CHECK NOW! You can look over any Audel Guide in your home. Start the Easy Payments if satisfied.

----CUT HERE----

MAIL ORDER

THEO. AUDEL & CO., 49 W. 23rd St., New York 10

Please mail me for 7 days' free examination the books marked (X) below. I agree to mail $1 in 7 days on each book or set ordered, and to further mail $1 a month on each book or set ordered until I have paid purchase price.

If I am not satisfied with Guides I will return them.

-] Audels PUMPS, HYDRAULICS & AIR COMPRESSORS $4.
-] Audels WELDERS GUIDE . . . . . 1.
-] Audels BLUE PRINT READING . . . . . 1.
-] Audels SHEET METAL WORKERS Handy Book . . 1.
-] Audels SHEET METAL PATTERN LAYOUTS . . 4.
-] Audels AIRCRAFT WORKER . . . . . 1.
-] Audels MATHEMATICS and CALCULATIONS . . 3.
-] Audels MACHINISTS & TOOLMAKERS Handy Book 4.
-] Audels DIESEL ENGINE MANUAL . . . . . 2.
-] Audels MECHANICAL Dictionary . . . . . 4.
-] Audels AUTO GUIDE . . . . . 4.
-] Audels MARINE ENGINEERS HANDY BOOK . . 4.
-] Audels SHIPFITTERS Handy Book . . . . . 1.
-] Audels MARINE Engineers Guide . . . . . 1.
-] Guethe MECHANICAL DRAWING COURSE . . 1.
-] Rogers Mechanical DRAWING and Design . . 2.
-] Audels MILLWRIGHTS and Mechanics Guide . . 4.
-] Audels CARPENTERS and Builders Guides (4 vols.) 6.
-] Audels PLUMBERS and Steamfitters Guides (4 vols.) 6.
-] Audels MASONS and Builders Guides (4 vols.) . 6.
-] Master PAINTER and DECORATOR . . . . . 2.
-] Audels GARDENERS & GROWERS GUIDES (4 vols.) 6.
-] Audels ENGINEERS and Mechanics Guides Nos. 1, 2, 3, 4, 5, 6, 7 and 8 complete . . . . 12.
-] Audels Answers on Practical ENGINEERING . . 1.
-] Audels Answers on REFRIGERATION . . . . 2.
-] Hawkins Aids to ENGINEERS EXAMINATION . . 2
-] Rogers MACHINIST GUIDE . . . . . 2.
-] Audels WIRING DIAGRAMS . . . . . 1.
-] Audels Handy Book of PRACTICAL ELECTRICITY 4.
-] Audels ELECTRICAL POWER CALCULATIONS . . 2.
-] Hawkins ELECTRICAL Guides at $1. each . . . 10.
-] Audels ELECTRONIC DEVICES . . . . . 2.
-] Audels ELECTRIC Dictionary . . . . . 2.
- Audels RADIOMANS GUIDE 4.
- Audels NEW ELECTRIC LIBRARY at $1.50 a Volume Vols. I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII.

Name. .....

Address. .....

Occupation .....

Employed by... P.S.M.

MEN 16 OR UP TO 50

Come to COYNE for a great future in

RADIO
COMMUNICATIONS AND ELECTRONICS

"Learn-by-Doing" on Real Radio Apparatus!

Airports, radio stations, film studios, police short-wave, television, industrial electronics—all need TRAINED RADIO SPECIALISTS. Learn the quick practical way, on actual equipment in the great Coyne Shops. Not by correspondence, but personal training based on 41 years of "know-how"!

I'LL FINANCE YOUR TRAINING!

Don't let lack of money hold you back. My plan lets you start now, pay tuition in easy monthly payments when you're trained and on the job. I help you get part time work to help pay living expenses while training, give you Lifetime Employment Service as a Coyne grad.

Prepares for Govt. License

Many of the better Radio jobs require government license. Coyne has enabled hundreds to pass this test successfully. You learn operating, learn to send Code rapidly, do trouble-shooting—handle real transmitting equipment, etc., etc.

Dozens of Branches to Choose From

Why be satisfied with a narrow, no-future line when by putting in a short time in my Shops, you can qualify for unlimited opportunities in RADIO AND ELECTRONICS, today's fast-growing fields! These pictures show only a few of countless well-paid jobs for trained Radio Operators.

SEND FOR FREE BOOK

Fully illustrated with big pictures of my Shops—facts about your future. Mail coupon now. No obligation. No salesman will call. Act today!

H. C. LEWIS, Pres., RADIO DIV.
COYNE ELECTRICAL SCHOOL
500 S. Paulina St. Dept. 43-4H
Chicago, Illinois

H. C. LEWIS, Pres.,
RADIO DIV., COYNE ELECTRICAL SCHOOL
500 S. Paulina St., Dept. 43-4H, Chicago, Illinois
Send me your BIG FREE Book about Radio, and details of easy "Pay-After-Graduation" plan.

NAME .....

ADDRESS .....

CITY ..... STATE .....

Buy War Savings Bonds and Stamps regularly.

"YOU ARE UNDER ARREST!"

There's a Thrill in Bringing a Crook to Justice Through Scientific

CRIME DETECTION!

I have taught thousands this exciting, profitable, pleasant profession. Let me teach you, too, in your own home. Learn Finger Printing, Firearms Identification, Police Photography and Secret Service Methods thoroughly, quickly and at small cost.

Be A FINGER PRINT Expert

53% of All American Bureaus of Identification employ students or graduates of I. A. S. You too can fit yourself for a responsible crime detection job with good pay and steady employment. But don't delay, get the details now. Let me show you how easily and completely I can prepare you for this fascinating work during spare time in your own home. You may pay as you learn. Write today. Now. Be sure to state age.

FREE!!! Send for Thrilling BLUE BOOK OF CRIME"

INSTITUTE OF APPLIED SCIENCE
1920 Sunnyside Ave., Dept. 1368, Chicago, Ill.

Why It Pays To

LEARN PHOTOGRAPHY NOW

Never before so many job and career opportunities! Photographers needed in business, industry, science. N Y I graduates winning promotion, higher pay in Armed Forces. Qualify at America's largest, oldest school. Resident or home study. FREE catalog describes commercial, portrait, motion picture and color courses. Write today!

N. Y. INSTITUTE of PHOTOGRAPHY, Dept. 5, 10 W. 33 St., New York 1, N. Y.

1953: A New World

The Commencement of Divine Order

A New World is emerging from the present conflict. A New Society is being born. Do you aspire to know its standards of Citizenship, its ideals and its aim, its history and achievements? 1953 marks the beginning of a New Era in a New World. What will it be like? How will it further human progress? Where will the cultural center be located? Read FREE BOOK THE INCOMPARABLE. 80 pages of answers with doctrinal information. Free. No obligation. Write Dept. 4.

LEMURIAN FELLOWSHIP
110 North Larchmont Boulevard Los Angeles, California

Correspondence Courses in RADIO and ELECTRICAL ENGINEERING

LOW AS $25

ELECTRICAL ENGINEERING. Get good grasp of wide electrical field. Many jobs available. Theory made easy.
RADIO ENGINEERING. Take the course in radio public address, photo-electric work. Training on real apparatus. Real vacuum tube technician. Tuition ONLY $25 either course. Deferred payment plan. Servicemen needed badly.

FREE Write for free copies of school's diploma, student manuals, etc.
LINCOLN ENGINEERING SCHOOL, Franklin Sta., Box 81 B59
(Formerly at Lincoln, Nebr.) WASHINGTON, D. C.

ARTISTS MAKE MONEY

Find out your ability. Send name, age, occupation and address for Free Vocational Art Test.

ART INSTRUCTION, INC., 11143 Art Instruction Bldg., Minneapolis, Minn.
(Formerly Federal Schools, Inc.)

BIGGER PAY THAN EVER!

Local "Store Route" Plan pays men like you big money—steady. To wholesale business of your own. No car to buy. Sell Vitamins and dozens of other fast repeat items. Your customers are all over. New low prices. Big repeat profits. Experience needed. Write us for a FREE. Write TODAY.

WORLD'S PRODUCTS CO
Dept. 83-L Spencer, Indiana

EARN MONEY PAINTING PORTRAITS

■ No previous training or talent necessary. Unique Stuart System teaches you, by mail, in 10 simple, easy-to-follow lessons, to make excellent charcoal and oil likenesses. Detailed guidance for your every step. Send for free book today.

STUART STUDIOS,
121 Monument Circle, Room 2811, Indianapolis, Ind.
Please send me free book and outline of lessons.

Name _____
Street _____
City _____ State _____

THIS MIRACULOUS TIME SAVING SLIDE RULE is Yours FREE!

If You Seize This Sensational Offer

Become a MATH Wizard! Get the Right Answers In a Flash Without Paper or Pencil!

MULTIPLY, DIVIDE, SQUARE, CUBE, EXTRACT SQUARE AND CUBE ROOTS AS EASY AS PIE!

An absolute gift worth a fortune to anyone in business, in a war job, or in the armed forces. A genuine, full-size Slide Rule, complete with an attractive, handy-carrying case! Solves the toughest math problems in a flash! All the features of a very expensive Slide Rule—six scales instead of four, plus a roots indicator. Free with the latest, newest printed book of its kind, "MATHEMATICS MADE SIMPLE."

EARN MORE MONEY IN YOUR JOB!

EARN A RATING— COMMISSION in the armed forces

10 in. Long

With handy Carrying Case. A, B, C, CI, D, K, Scales. Log-Log Slide

"MATHEMATICS MADE SIMPLE"

NEW, AMAZING "FIGUR-EASE" METHOD!

The Latest Complete, Time Saving Home Study Book For Your Spare Time

A math education helps you get ahead. This book makes learning math simple, interesting and exciting fun. The latest book of its kind. Written as if you had a college professor sitting at your elbow explaining all the main rules: the short cuts, the professional tricks—with examples of each step. It takes the headaches out of math!

COMPLETE ANSWERS TO ALL PROBLEMS

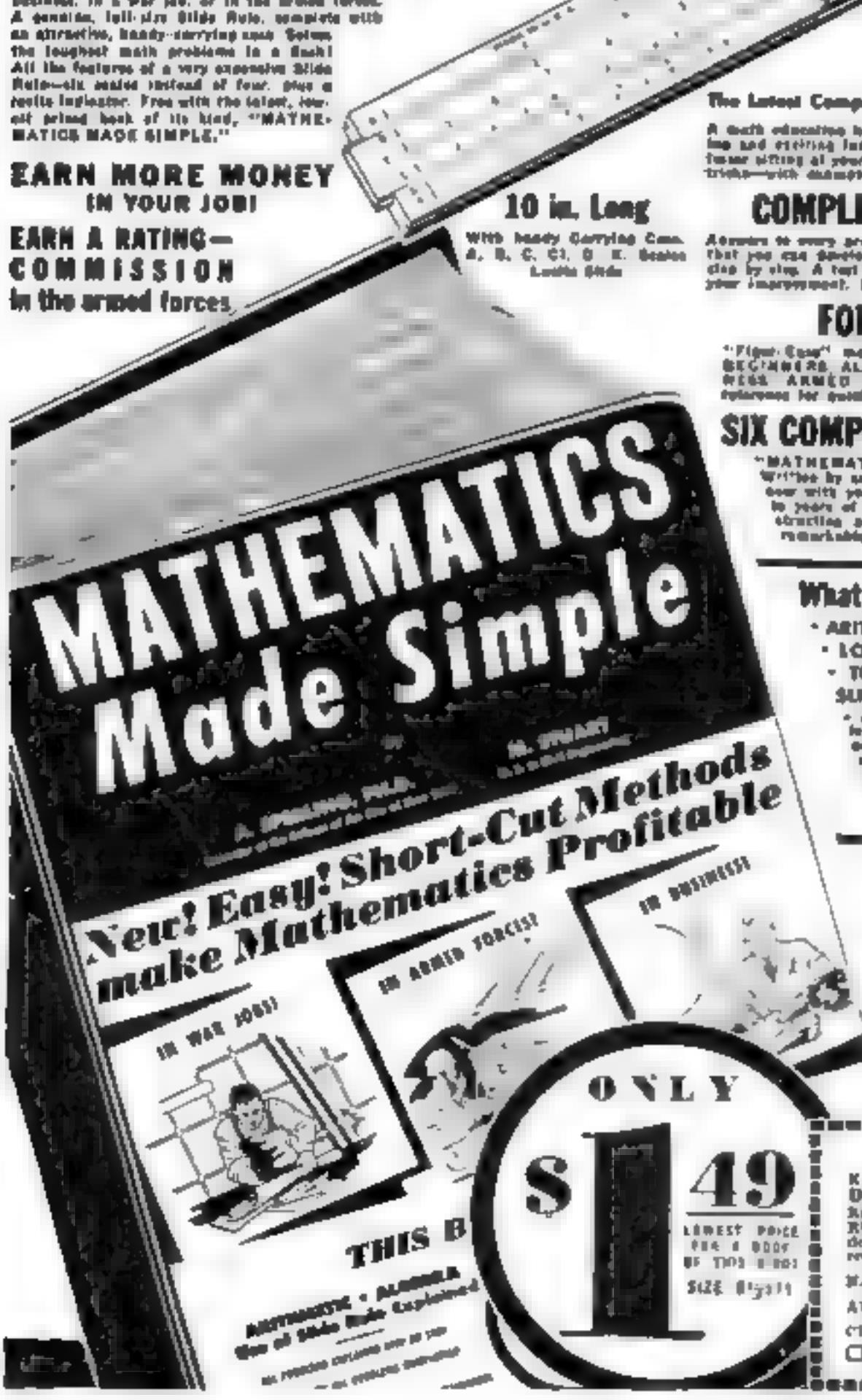
Answers to every problem worked out in detail. Practice exercises follow each lesson so that you can develop speed and accuracy. Problems in your every day work, explained step by step. A test at the start points out your weaknesses and a test at the end shows your improvement. Plus many more invaluable features!

FOR BEGINNERS AND EXPERTS!

"Figur-Ease" method makes math a "cinch" for everyone ever using a pencil—BEGINNERS, ALL WAR WORKERS INCLUDING ENGINEERS, TRADE IN INDUSTRIES, ARMED FORCES, STUDENTS, ETC. Also ideal for a "brush up" and reference for quick answers. A "must" for everyone!

SIX COMPLETE BOOKS CONDENSED INTO ONE!

"MATHEMATICS MADE SIMPLE" is streamlined for simple, enjoyable study. Written by an expert teaching in one of the largest universities, and a civil engineer with years of applying math on the job. Contains six main sections—equal to years of school training—now condensed into one book for time saving instruction at the lowest price for so great a value—only $1.49 including the remarkable Free Slide Rule!



What the "Figur-Ease" Method Teaches You!

- ARITHMETIC • ALGEBRA • PLANE AND SOLID GEOMETRY
- LOGARITHMS • SCALES • GRAPHS • SHOP MATH
- TRIGONOMETRY (TANGENTS) • HOW TO USE THE SLIDE RULE, ETC.

• All problems explained step by step. • Answers to all problems completely worked out. • A test at the start to show weaknesses. • A test at the end to show improvements. • How to solve actual on the job problems. Invaluable as in the actual jobs for passing tests in Armed Forces, War Work, Civil Service, etc.

PLUS MANY MORE PRACTICAL FEATURES

PRAISED TO THE SKIES BY NEWSPAPER REVIEWERS:

"A life raft for those whose jobs have plunged them head-on into mathematical calculations without special training in the higher brackets." —OAKLAND TRIBUNE

"Designed for those who want knowledge and want it QUICKLY. NEW and EASIER SHORTCUTS in mathematics" —GALVESTON TRIBUNE

"If can't be done? These authors show that it can." —TAMPA TRIBUNE

SEND NO MONEY—EXAMINE FREE

Simply mail the coupon. Don't send a cent. Rush your order—there are limited copies due to paper rationing. See for yourself how much this book can do for you—NOW AND IN PEACETIME!

FREE GIFT COUPON

KENMORE PUBLISHING COMPANY,
Dept. B 17, 220 Fifth Ave., N. Y. C. 1

Rush to me "Mathematics Made Simple" with my FREE SLIDE RULE GIFT and carrying case. I will deposit with postman on delivery $1.49 plus postage. If not satisfied within 5 days I may return book for refund.

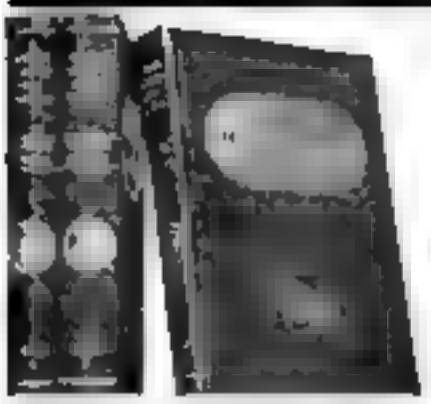
NAME .....

ADDRESS .....

CITY ..... STATE .....

☐ Check here if you wish to save postage by enclosing only $1.49 with coupon. Canada Orders—No C. O. D.—Send $2.00

Sent FREE for 7-Day Trial
MACHINE SHOP TRAINING COURSE



FOR BEGINNERS & EXPERTS

Easiest, Quickest Way to Get

MACHINIST TRAINING

Compiled by practical machine shop experts. Modern Machine Shop Training—shipped you promptly FREE for 7 day examination. Actual Lesson Assignments, shop texts, with same training procedure and instruction as given students in our huge Los Angeles shops. Hundreds of illustrations, diagrams, charts, tables. Beginners and experts need this proved course. Mail Coupon at once and also receive FREE 7 Drafting Lessons, Machinist's Dictionary and 2 Shop Math. Texts.

Machine Tools fully described, demonstrated. Lessons in all kinds of bench work. Instructions to tool up, operate machines. Hundreds of short cuts Enable you to get Expert's Pay.

NATIONAL SCHOOLS
Los Angeles, Calif.

3 BIG VOLUMES-SEND NO MONEY

NATIONAL SCHOOLS, Dept. L-11
4000 S. Figueroa St. Los Angeles 37, Calif.

Paste on Penny Postcard

Ship your 3-VOLUME MODERN MACHINE SHOP TRAINING COURSE postpaid. Within 7 days after receiving Course (and Bonus Gift) I will either return shipment and owe you nothing; or if satisfied I'll send $2.00 and $1.00 a month until total of $12.50 is paid (final payment $7.50). You may deduct $1.25 if you enclose cash ($11.25) with this Coupon. Same return privilege.

NAME

ADDRESS

CITY STATE

OCCUPATION AGE

FIX ANY RADIO
Amazing New Invention

Learn quickly to repair all radio sets. Now, revolutionary different **Comparison** method permits you to do expert work at once immediately. No previous radio knowledge required. Introductory training included. Find any fault quickly. Use a screw driver, pliers and a piece of wire — no testers needed. Simple point-to-point picture suggestions tell you where to look for faults and how to make the repair. Plan U. S. Copyrighted. Covers every radio set, new and old. You may try the plan for 10 days without risk.

Easy to Apply

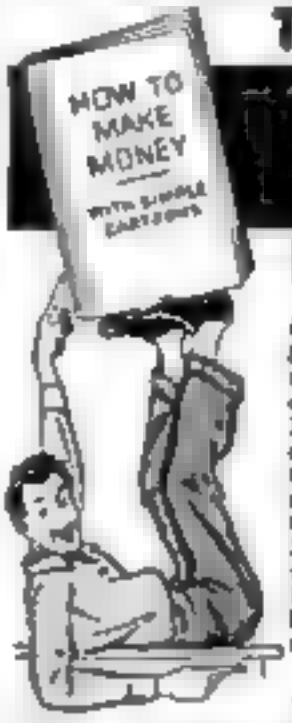
SATISFACTION GUARANTEED

Read the introductory job sheets, follow the step-by-step picture hookups, and fix any radio in minutes instead of hours. The complete simplified training is yours for only $4.50, postpaid, in days trial. Money back guarantee.

Price only $4.50, postpaid. In large Manual form, 8½ x 11 in., 112 pages. Data on 346 radio tubes, 18 trouble-shooting blueprints. Over 1,000 time-saving service hints. Developed by M. N. Beitman, noted engineer and author. Order without risk for 10 days use. Write today.

SUPREME PUBLICATIONS
328 S. Jefferson St. Chicago 6, Ill.

THIS VALUABLE BOOK
FREE



LEARN CARTOONING AT HOME IN SPARE TIME

Send for this FREE book containing money-making tips, cartooning charts, idea creating methods, list of cartoon buyers, and other valuable information. Read about the money-making opportunities in one of the most fascinating of all professions—CARTOONING. With this booklet we will include a complete portfolio describing our easy Course in Cartooning and explaining our new Marmonette Method of Instruction. We will also tell you how to get the Cartoonists' Exchange Laugh Finder FREE of extra cost. This amazing device actually helps create and originate humorous ideas. Send name at once and mention your age.

CARTOONISTS' EXCHANGE
Dept. 14411, Pleasant Hill, Ohio

Make BIG MONEY AT HOME!
NEW Invention Electroplates by BRUSH

Now Plates CHROMIUM!

ALSO GOLD, SILVER, NICKEL, COPPER ETC.

War Increases Demand—You Profit

New, patented Invention makes possible big earnings AT HOME. Replate auto-parts—worn articles in homes, stores, hotels, restaurants, etc., with durable, sparkling, new coat of metal—with stroke of brush. Easy, simple, quick. Genuine Gold, Silver, Nickel, Cadmium, etc. Everything furnished. Outfit complete, ready for use. No shop required. Clear from $2 to $5 an hour in lifetime business. Small investment starts you in business. Steady repeat. Machine can pay for itself in week. Send TODAY for FREE SAMPLE and illustrated BOOKLET how you can have a life income from a business of YOUR OWN built upon satisfied customers. Act at once!

WARNER ELECTRIC COMPANY
663 N. Wells St., Chicago, Ill., Dept. 467

FREE BOOK & SAMPLE

WARNER ELECTRIC CO., 663 N. Wells St., Chicago, Ill., Dept. 467

Gentlemen: Send me Free Sample and Illustrated Booklet.

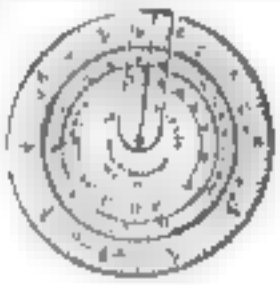
*Name*_____

*Address*_____

City *State*

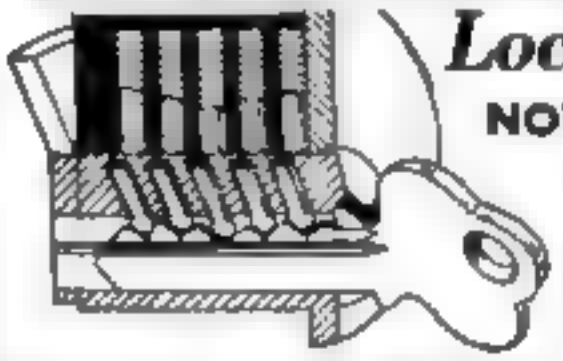
Buy War Savings Bonds and Stamps regularly.

MASCOT SLIDE RULE



Fits the pocket. Quickly solves any problem in multiplication, division, proportion. Gives the square, the square root, logarithm and reciprocals of all numbers. Trig scales give sines and tangents of numbers. Fine black graduations on white celluloid. Price in fabricoid case $1.00, in leather case $1.25. Money back if not satisfied. Special offer to agents and dealers.

TAVELLA SALES CO., 21 West Broadway, New York, N. Y.



Locksmithing
NOW MADE EASY!

New course for practical men, mechanics, carpenters, fix it shops, etc. Learn in 30 days, pick locks, de-code, make masterkeys. It pays. Send name for FREE details. No obligation — write today!

Nelson Co., 321 S. Wabash, Dept. L-703, Chicago.

GENUINE U. S. BARGAINS

O. D. Wool Blankets (used) $2.95
U. S. Army Hat or Bags (New) .49
U. S. Army Pup Tents (used) 2.50
Slightly Used Army Caisson Wheels with Axles, 56" high, Wt. 322 lbs. $37.50
Thousands of other bargains in military, outdoor & sport goods for hunter, farmer, scout. Send 10c for 32 page catalog refunded with first order.

A and N SUPPLY CO.
4754 LESTER ST. RICHMOND, VA.

Large Manufacturer Will Pay Cash or Royalty for New Items

Here is your chance to cash in on your inventions for new products made of metal. These can include machine parts, new equipment, or production parts. Write fully, giving descriptions, send sketches if needed—tell us your price. We will arrange meeting if interested—or return your material. Write M.M.C., 11th Floor, 353 Fourth Ave., New York 10, New York.

PLASTICS

THE GREAT *New* FIELD OF OPPORTUNITY

PLASTICS ENGINEERS AND TECHNICIANS NEEDED IN NOT ONE BUT MANY CLASSES OF INDUSTRY

● Leaders in science and industry have long been saying, "Keep your eye on Plastics." But now the time for action has arrived. The future of huge possibilities has already begun. Developments in Plastics for hundreds of wartime uses have set the pace for revolutionary changes in peacetime production of thousands of products.

THIS IS YOUR BIG CHANCE

Today there's a big need in vital war production for those who are trained in Plastics. From one to a hundred articles made of Plastics must be supplied for every man in our fighting forces. Start training now in Plastics Engineering, in spare time in your own home. Fit yourself for a responsible, well-paid position. Help to win Victory. And at the same time you will be preparing for even greater opportunities when the war is over.

There is scarcely an industry in which these so-called "miracle materials" will not play an important part. After the war many old materials, methods and skills will be replaced. Acquire the all-important "know how." Be in a position to step into one of the key jobs.

YOU CAN LEARN WHILE YOU EARN

Turn at least part of your leisure time into money. Qualify at home for a larger income in an interesting career. Build greater security for your future in a vocation that looms large on the horizon of the new industrial era. Hours you might otherwise waste can put you well on your way toward lasting success.

It's easy to find out about Plastics training. To get details and outline of study prepared by specialists, and about the school that has helped thousands to success during the past 46 years, write us or check and mail the coupon. Send today. The sooner you take this easy step, the sooner you will reach your goal and reap the rich rewards.

AMERICAN SCHOOL OFFERS COMPLETE TRAINING SERVICE IN MANY SUBJECTS

You who have not completed high school or have missed vocational training in college, and who cannot spare time to go away to school, can complete your education in your choice of many subjects. Several of these are listed in the coupon at right. Check the subject in which you are interested, fill in your name and address, clip and mail the coupon today.

AMERICAN SCHOOL

Dept. G-846, Drexel at 55th Street, Chicago 37

PRACTICAL, EFFECTIVE HOME-STUDY TRAINING SINCE 1897

Take This First Easy Step

CHECK, CLIP AND MAIL COUPON NOW

AMERICAN SCHOOL, Dept. G-846, Drexel at 55th, Chicago 37, Ill.

Without obligation, Please send FREE and postpaid, bulletin and details of the Subjects checked.

☐PLASTICS ENG'R	☐Accounting and C. P. A.	☐Drafting and Design for Men and Women
☐Refrigeration	☐Cost Accounting for Manufacturing	☐Radio
☐Architecture and Building	☐Bookkeeping	☐High School
☐Practical Plumbing	☐Private Secretary	☐Air Conditioning
☐Automotive Engineering	☐Diesel Engineering	☐Shipbuilding
☐Aviation Drafting	☐Surveying & Topographical Drafting	☐Mechanical Eng.
☐Aviation	☐Sheet Metal Pattern Drafting	☐Shop Management
☐Business Management	☐Electrical Engineering	☐Tool Making
		☐Better Foremanship
		☐Machine Shop Operations

Name .... *Occupation* .....

Address .... *Age* .....

City.... *State*.... .....

HERE IS YOUR SUCCESS CHANCE
BE A
RADIO-ELECTRONIC TECHNICIAN

SPRAYBERRY TRAINS YOU QUICKLY FOR WAR AND PEACETIME WORK

You Learn In Easy Step-By-Step Stages
No Previous Experience Needed

The offer I make you here is the opportunity of a lifetime. It's your big chance to get ready for a wonderful future in the swiftly expanding field of Radio-Electronics INCLUDING Radio, Television, Frequency Modulation, and Industrial Electronics Equipment. NOW is the time to act. Aside from future considerations, just think of the IMMEDIATE possibilities in Radio during war time. They're tremendous! Best of all, it's easy for the beginner to get started through my quick, practical training.

Prepares You For A Business of Your Own
. . . or Good Radio Jobs, Civilian or Military

The Sprayberry course is short, intensive and interesting. It starts right at the beginning of Radio. You can't get lost. It gets the various subjects across in such a clear, simple way that you understand and remember. I make it easy for you to learn Radio Set Repair and Installation Work . . . . by practical, proved, time tested methods. I teach you how to install and repair Electronic Equipment and give you the broad fundamental principles so necessary as a background no matter what branch of Radio you wish to specialize in. Soon you'll be qualified for a [illegible] one of the nation's Radio [illegible] war work OR, if you enter the [illegible] Marines, my training will help [illegible] and better pay. Let me [illegible] Sprayberry training can do for you.

JUST OFF THE PRESS!

"How to Test and Repair Radio Sets Without Meters"

Developed in the Sprayberry Laboratory, this instructive volume tells about an amazingly simple, yet efficient method for Radio trouble-shooting and repair without use of regular equipment made scarce due to war. Send for this FREE book now while the supply lasts and along with it, I will send you another big FREE book describing my Radio Electronic training. Use coupon below.

MAIL COUPON

SPRAYBERRY ACADEMY OF RADIO
F. L. Sprayberry, President
852-L University Place, N. W., Washington, (9) D. C.

Please rush my FREE copies of "HOW to TEST and REPAIR RADIO SETS Without METERS" and "HOW to MAKE MONEY in RADIO."

Name ..... Age .....
Address .....
City ..... State .....
(Mail in plain envelope or paste on penny postcard)

Buy War Savings Bonds and Stamps regularly.

DRAW for MONEY

Be An ARTIST!

Trained Artists Are Capable of Earning
$30-$50-$75 A WEEK

Use Your Spare Time to Prepare For a Profitable Art Career

It's interesting and pleasant to study Art the W. S. A. way. **COMMERCIAL ART, DESIGNING, CARTOONING**—all in ONE complete course. No previous Art experience necessary—hundreds have profited by our practical home study method since 1914. Write today for information in FREE BOOK "Art for Pleasure & Profit". Tells all about our course, service—and commercial opportunities for you in Art. State age.

WASHINGTON SCHOOL OF ART
Studio 1311-F, 1115-15th St., N. W., Washington 5, D. C.

ENGINEERING DEGREE IN 27 MONTHS

INDIANA TECHNICAL COLLEGE

Courses in Aeronautical, Chemical, Civil, Electrical, Mechanical and Radio Engineering. One year courses in Business and Drafting. Approved by C. A. A. Prep courses without added cost. Low tuition. Large industrial center. Opportunity to earn part living expenses. Enter December, March, June, September. Catalog.

1913 E. Washington Blvd., Ft. Wayne, Ind.

LAW

STUDY AT HOME for PERSONAL SUCCESS and LARGER EARNINGS. 31 years expert instruction. over 108,000 students enrolled. LL.B. Degree awarded. All texts furnished. Easy payments. Send for FREE BOOK—"Law and Executive Guidance".

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 35-B 5 East Huron St., Chicago, Ill.

MONEY IN RABBITS—CAVIES

WE BUY and put you in touch with other markets. Catalog and copy of magazine 10c. Or send 25c for Book, Catalog and Price List and Start a Rabbitry. Write to the AMERICAN SMALL STOCK FARMER.

OUTDOOR ENTERPRISE CO., Box 6, PEARL RIVER, N. Y.

A FROLIC READER FOR THE GENTLEMAN

Here indeed is *Reading for Pleasure*. THE PLAYBOY'S HANDBOOK is a clever, cheerful, sly collection of American Humor at its best. It's a man's book, just like hunting is a man's sport. Ranging from the sublime to the ridiculous, it features such exhilirating curiosa as

Just A Freudy-Cat, by **Jack Hanley**; Mythology from "The Bachelor Life", by **George Jean Nathan**, Advice To A Young Man On The Choice Of a Maiden by **Benjamin Franklin**; Mr Preble Gets Rid Of His Wife, by **James Thurber**, The Greeks Had A Yen For It by **Gilbert Seldes**; The 99-44 100% Puritans by **Duncan Underhill**, For Women Only by **Marjorie Daw**, Slag Lines by **Wm. Alan Brooks**; A Trip To Hollywood, by **Frank Sullivan**; The Art Of Persuasion, by **Stephen Moore**, plus other articles, cartoons, stories, gags and nonsense!

Do not deny yourself the enjoyment of these frivolities. The price is only $1.00, the pleasure a thousandfold. Mail the coupon now.

KNICKERBOCKER PUB. CO.
120 Greenwich St., Dept. D-224, New York 6, N. Y.

Send me a copy of "THE PLAYBOY'S HANDBOOK," It's guaranteed to be a riot of fun—or my money back.
( ) I am enclosing $1.00 ( ) Send C.O.D. plus postage

Name..... City.....
Address..... State.....

RICH REWARDS FOR THOSE WHO KNOW PLASTICS

BE A PLASTICS TECHNICIAN

Do you want action *now*—in a vital, growing war-time industry . . . helping to turn out fighting planes and jeeps and bombs and tanks? There's a big demand for men and women plastics technicians to fill important war industry positions . . . and if you start your training now—at home—you may qualify for a place in this vital part of the war program

LOOK TO THE FUTURE

Even more important is the question—what will you do when the war is over? Will you be among those fighting for jobs that may no longer exist? *Or will you be well on your way to a permanently profitable career, or established in your own business, with plastics?*

Build your personal post-war plans on a sound knowledge of plastics. This country is already in the Plastics Era. The future of the plastics industry is so rich that some predictions seem exaggerated and fantastic . . . but the fact remains that plastics have proven themselves and are vital in the production of airplanes, autos, furniture, radios, trains, clothing, electrical appliances and equipment, machinery, tools, and hundreds of other products

CHOOSE YOUR FIELD . . . *Enter it thru PLASTICS*

You should be able to see for yourself what plastics will mean in virtually every field—the possibilities that will be available to those trained in plastics. Now is the time to prepare for your chosen field, as a plastics technician.

LEARN AT HOME

Make your increased hours at home pay you dividends. You can easily fit into your spare time your training for a career in plastics. You won't need to lose one minute from your present work . . . simply devote a few hours each week to enjoyable home study, like thousands of other men and women are doing who are helping their country while helping themselves. The Plastics Institute course is an easy, practical tested method which will help fit you for this promising and interesting field and if you are now working with plastics, it equips you for advancement. During the entire course your training is supervised by men well known in the plastics industry, in which they have been recognized as authorities for years.

TIME IS PRICELESS—ACT NOW!

Find out how the Plastics Institute can help YOU. Mail the coupon for your copy of the large FREE, illustrated booklet, the "World of Plastics." It is crammed with valuable information about plastics, tells about the new plastic airplanes and other uses for this revolutionary new material as well as about the opportunities for YOU in plastics. Decide NOW to let plastics point the way to YOUR success send the coupon TODAY

STUDENTS REPORT SUCCESS

"I wish to acknowledge, with thanks, the receipt of my final examination papers, my certificate of graduation, and the lesson binders you sent me.

"I have really enjoyed your excellent course of study, and the friendly help and cooperation you have given me, and feel that the time and money expended on my training has been well worthwhile

R.F.P.

Plastics

INDUSTRIES TECHNICAL INSTITUTE

AMERICA'S ORIGINAL PLASTICS SCHOOLS

1220-D Chanin Bldg. New York — 626-D LaSalle-Wacker Bldg. Chicago — 194 So. Alvarado St. Los Angeles

MAIL COUPON FOR FREE BOOK

Plastics Industries Technical Institute
626-D La Salle-Wacker Bldg., Chicago

Gentlemen: Please send me the booklet "World of Plastics" and information on your training program. I understand there is absolutely no obligation.

Name_____ Age_____

Street_____

City_____ State_____

Dept. 11

Specialists Wanted

IN MANY BRANCHES OF AVIATION

Train in Miami!

This is the day of unequalled opportunity in aviation, IF you have the right kind of training. You can get such training in beautiful Miami and build a career in one of the world's fastest growing industries. Choose the branch of aviation in which you want to make your success. Embry-Riddle can train you for an important, big-pay job in that branch. Check, fill in and mail coupon AT ONCE for 24-page booklet of valuable information. Don't delay.

Embry-Riddle

School of Aviation

MIAMI 30, FLORIDA

Dean of Enrollments, Dept. 9
Please send me information about aviation training at Embry-Riddle.

- ☐ Instrument Technician
- ☐ Aircraft Mechanic
- ☐ Radio Communications
- ☐ Link Instructor
- ☐ Drafting and Design
- ☐ Aircraft Engine Mechanic
- ☐ Check here for details of ALL available courses

Name .....

Address .....

.....

HEAR a world of sound through a MAICO

Small, light and easy to wear, yet enables hard of hearing person to carry on normal conversation at 20 feet—to hear even a whisper with loud noises cushioned.

Send name of relative, friend or your own name for a new experience in hearing. No obligation. Address Maico Co., Inc., Dept. 50-K, 2632 Nicollet Avenue, Minneapolis.

MAICO
Vacuum Tube
Hearing Aid

A product of the Maico Company which provides 90% of America's precision hearing test equipment. Choice of ear physicians, hospitals, universities, clinics, clinics, U. S. Army and Navy.

RADIO

ENGINEERING, Broadcasting, Servicing, Electronics, **Aviation,** Marine & Police **Radio taught thoroughly.** 48 weeks **Engineering course equivalent to 3 years' college radio work. School established 1874,** all expenses low. Co-educational. Catalog free.

Dodge Institute. Dept. 503 Valparaiso, Ind.

MAKE EXTRA MONEY FAST

Sell ILLUSTRATED COMIC BOOKLETS for adults (vest pocket size) and other novelties. 10 different sample booklets sent for 50c or 25 assorted for $1 or 100 assorted for $2. Shipped prepaid. Wholesale novelty price list sent with order only. No C. O. D. orders. Send Cash, Stamps or Money Order.

GRATKO, Dept. 21 Box 520, G. P. O., New York

DRAFTING

MORE DRAFTSMEN NEEDED in all manufacturing and building lines—$30 to $50 a week and up. Learn at home in spare time. Write NOW for FREE Booklet. No obligation.

American School

Dept. DD546, Drexel & 58th, Chicago 37

REFRIGERATION

MECHANICS SPARE TIME COURSE

Learn at home—how to start your own repair shop on little capital. No previous experience needed. Common school education sufficient. Splendid opportunity for older men. Prepare now for after the war. Write for illustrated booklet.

MECHANICS TRAINING SCHOOL, Dept. PS-8 4701 W. Pico Los Angeles 5, Calif.

Learn

MECHANICAL DENTISTRY AT HOME!

To make Crowns, Plates, Bridgework, etc. for Dentists. Interesting way to learn. Practical dental lab. course. [illegible] THOUSANDS MAY BE NEEDED. Write today for [illegible] this money making profession that is not affected.

McCARRIE SCHOOL OF MECHANICAL DENTISTRY
207 N. Broad St. Dept. M20 Philadelphia, Pa.

JOKE BOOKS FOR ADULTS

The kind they like. You will be both a Riot and the Life of the Party with a set of these pocket size Joke Books. They are full of Entertainment, Fun and Humor. A set of six books only 50c or a super assortment of 12 books all different for $1.00. Print name and address, send cash or stamps to:

TREASURE NOVELTY CO.

72-5th Ave., Dept. 1411, N. Y. 11, N. Y.

Learn Profitable Profession in 90 days at Home

[illegible]

THE COLLEGE OF SWEDISH MASSAGE
100 E. Ohio St., Dept. 470 Chicago 11

STUDY AT HOME

With A Chartered Educational Institution

Courses in ENGINEERING: Electrical, Civil, Mechanical, Drafting, Architectural, Steam, Aeronautical, Radio, Structural, Mining, Industrial, Highway, Petroleum, Marine, Chemical.
Courses in ARTS AND SCIENCES: Philosophy, Education, Letters, Public Health, Medical Jurisprudence, Psychology, Sociology, Physics, Chemistry, Geology, Pre-Science, Theology, Law, Business and Commerce, Accounting, Mathematics, Statistics, Agriculture.
McKinley-Roosevelt Incorporated, 4810-AC, Sheridan Road, Chicago, 40

DO YOU

WANT a permanent business profession of your own? **Then become a foot correctionist. Earnings of men and women in this greatly needed profession run as high as $50.-$100. weekly after a few weeks home training—not medical or chiropody—easy terms, no further capital needed, no goods to buy. 41th year. Write for free booklet.**

Stephenson System of Foot Correction, 82 Back Bay Boston, Mass.

New you can own these "Western Union" Electric

RADIO TELEGRAPH SENDING & RECEIVING SETS

You Get 2 Sets Like This

[illegible]

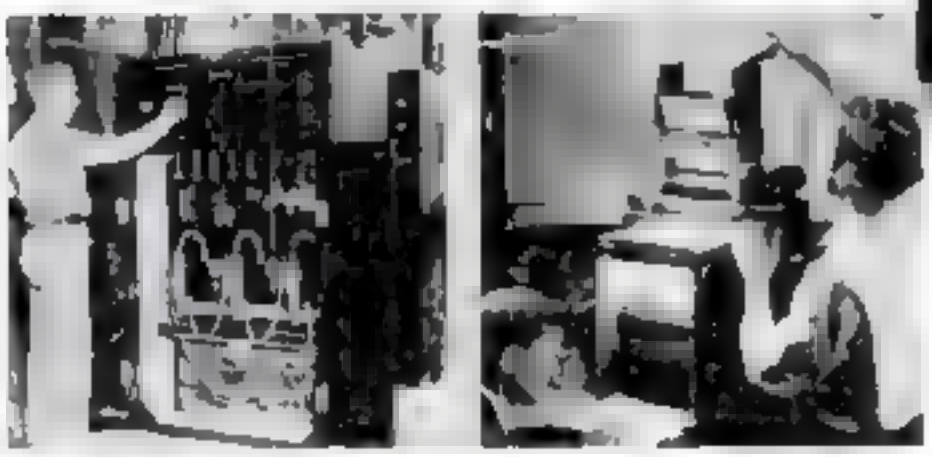
Money Back Guarantee

RADIO WAREHOUSE MARKET 362 Wooster Ave., Akron, Ohio **FREE!**

Tear out this ad, write name and address in margin, mail $3.95 and we will send outfits at once POST PAID. Or order C.O.D. pay postman for outfits plus postage

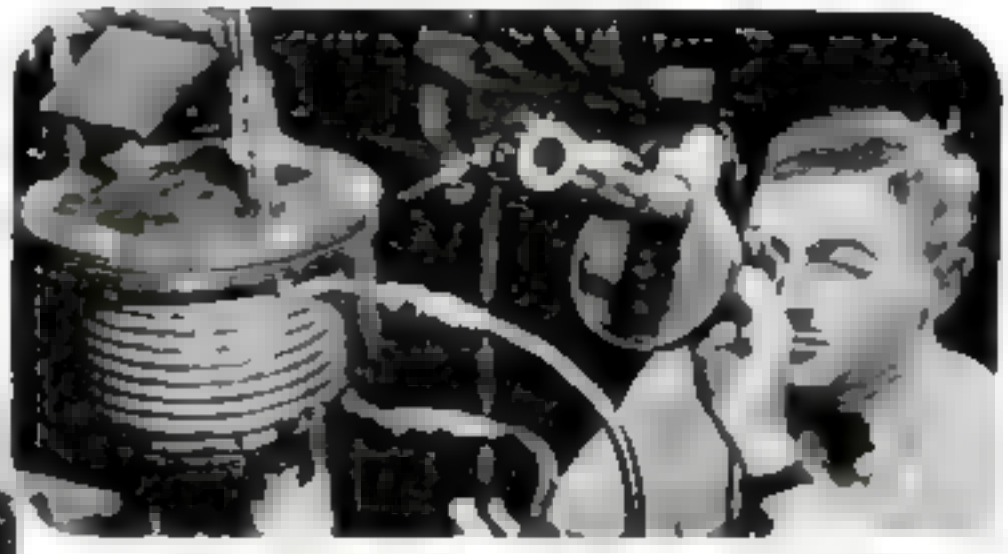
Get into *RADIONICS now

Learn INDUSTRIAL ELECTRONICS TELEVISION & RADIO



Out of the War is emerging the Age of Electronics, with immediate opportunity for you to enter America's new Industry

*Radionics is a general term embracing Industrial Electronics, Television and Radio. Electronics for harnessing the forces of Industry, Television to bring the world's sights into the home, Radio with revolutionary improvements—these are developments that constitute a tremendous field. You can project yourself into this mighty field. You can become part of it. You can earn good pay as a Radionics Expert, with independence insured during and after the war. When the war ends, Radionics will boom even faster than now. But you can't successfully enter this field unless you have TRAINING. Let's speak plainly. You have the desire and you realize the tremendous future of Radionics. But you lack training. So here's the way to get into Radionics. Have National Schools train you right in your home. National is always in the lead. As industry advances National offers training to fit. This was never more true than today. National's training covers all phases of Radionics. You learn by following fascinating lesson assignments, based on practical shop-laboratory methods. Instructors give you the same fundamental training that you would receive if you were actually in the school. It's an amazing extension of resident school training.



How you can qualify as a Technician in the fascinating field of RADIONICS—including Electronics, Television & Radio

TESTED HOME TRAINING BY PROVED SHOP-FIELD METHOD

For more than 38 years National Schools has trained thousands of men. Many graduates hold top positions in hundreds of leading industries. Unlike ordinary correspondent courses, National's Radionics Course is based on shop-practice, shop-tested shop-routine training, adapted to *Home Study*. Replacing dry text books, fascinating Lesson and Experimental Assignments are provided. Instructors counsel with you. After the first few Lessons you are qualified to repair Home Radio Sets. Soon you master Communications and Sound Systems. Before you realize it you have practical knowledge of the 'workings' of countless Electronics Controls and how Electronics is applied to Industry. When you graduate you are qualified to accept a job that should pay substantially more than you are now earning. This is a real opportunity for you.

NATIONAL SCHOOLS of Los Angeles presents HOME TRAINING IN RADIONICS

New opportunity Book, all about Radionics and 1 RIT lesson mailed without obligation.

Mail This Coupon Today

MEN OF ALL AGES TRAIN TO

[illegible]

Radio Serviceman
Electronics Engineer
Studio Technician
Television Expert
Machine Control Engineer
Communications & Sound Engineer

TRAINING IS BROUGHT TO YOU. Every day some new development in Radionics takes place. National's instructors are always on the alert to study each new invention and weigh its advantages. The Course reflects this up-to the minute checking so that you as a student get the latest first. The more time you can devote to this training the sooner you graduate. The Course is geared to your needs. You keep your present job while learning. Many students, soon after enrolling, earn extra pay by servicing neighbors' Radio Sets and working in established Radio Shops. Many students are men who have already devoted years to Radio and want to improve their abilities by obtaining thorough training in the entire field of Radionics. So regardless of your age or experience you can increase your pay and insure your future by enrolling

FREE RADIONICS BOOK & LESSON

NATIONAL SCHOOLS DEPT. PS-11
4000 SOUTH FIGUEROA,
LOS ANGELES 34, CALIFORNIA

(Paste on a penny postal)

Send Radionics Book, Lesson and full details, postpaid without obligation.

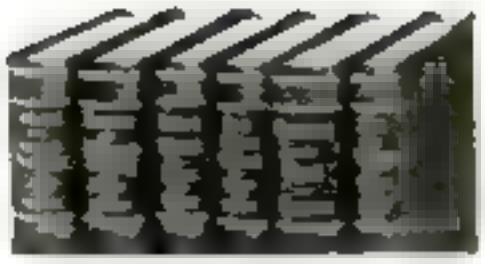
NAME_____ Age_____

ADDRESS_____

CITY_____ STATE_____

NEW!

Increased production



MORE JOBS for MACHINISTS

and bigger pay for men who know their work

This big home study and reference course gives you the practical facts on machines and methods you need to advance in machine shop work. Take advantage of the other man's experience as found in books, to solve your problems, increase your efficiency, with

The AMERICAN MACHINISTS' LIBRARY

6 volumes—2368 pages—2516 illustrations
(A combined home-study course and reference library)

This library of machine shop practice was written for practical men. It gives you the best methods for every kind of machine shop work. It fully explains lathes, drills and other machine tools and their operation, automatic screw machines, speeds and feeds, gear design and production, jigs and fixtures, punch and die work, metal surfacing, etc., etc. Plainly written, completely illustrated—the best kind of help to the machine shop man who wants to advance himself.

No money down—special price—easy payments.

EXAMINATION COUPON

McGRAW-HILL BOOK CO., 330 W. 42nd St., N. Y. C. 18

Send me for ten days' examination the American Machinists' Library. If satisfactory I will send you $1.50 in 10 days and $3.00 monthly until the price of $19.50 is paid. If not wanted I will return the books postpaid. (To insure prompt shipment write plainly and fill in all lines.)

Name .....
Home Address .....
City and State .....
Position .....
Name of Company .....

PSM 11-43

KEY TO A PRACTICAL UNDERSTANDING OF ELECTRICITY

$1 per week

• AUDELS HANDY BOOK OF ELECTRICITY

$4 HANDY SIZE

For Engineers, Electricians, Students and all interested in Electricity. A quick, answered, ready reference, giving complete instruction and practical information. Easy to understand. A reliable authority and a handy helper that answers your questions.

• INSIDE TRADE INFORMATION ON

The Rules and Laws of Electricity—Maintenance of Machinery—A. C. and D. C. Motors—Armature Winding and Repair—Wiring Diagrams—House Lighting—Power Wiring—Cable Splicing—Meters—Batteries—Transformers—Elevators—Electric Cranes—Railways—Bells—Sign Flashers—Telephone—Ignition—Radio Principles—Refrigeration—Air Conditioning—Oil Burners—Air Compressors—Welding, and many other Applications explained so you can understand.

1340 PAGES
2600 ILLUS.

To have this assistance for yourself, simply fill in and mail the **FREE COUPON** below.

THEO. AUDEL & CO., 49 West 23rd Street, New York

Please send me "Audels Handy Book of Practical Electricity" for free examination. If satisfactory, I will send you $1 in 7 days, then $1 monthly until $4 is paid. Otherwise I will return it.

Name _____
Address _____
Occupation _____
Reference _____

PSM

READ FOR PROFIT!

Buy War Savings Bonds and Stamps regularly.

Do You Make Mistakes in English?

EVERY time you speak or write you show just what you are. Mistakes in English reveal you as a person who lacks education and refinement. Lack of language power prevents you from presenting your thoughts in the strongest possible way. No matter what you do, real command of English will help you to your goal. Stop making mistakes in spelling, punctuation, pronunciation. Increase your vocabulary.

WONDERFUL INVENTION

Only 15 minutes a day with Sherwin Cody's new invention, and you can actually SEE your English improve. It teaches by HABIT, makes it easier to do the RIGHT way. Wonderful, self-correcting lessons include spelling, punctuation, Grammar and expression.

FREE BOOK ON ENGLISH Lack of language power may easily be costing you thousands of dollars every year. See what Mr. Cody can do for you. It costs nothing to find out. Mail a postal card or letter this very minute for free book, How You Can Master Good English in 15 Minutes a Day. It will prove a revelation to you. WRITE NOW. Address:

Sherwin Cody School of English, 1811 Searle Bldg., Rochester 4, N. Y.

LAW

STUDY AT HOME for PERSONAL SUCCESS and LARGER EARNINGS. 39 years expert instruction—over 108,000 students enrolled. LL.B. Degree awarded. All texts furnished. Easy payments. Send for FREE BOOK "Law and Executive Guidance."

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 38-S, 3 East Huron St., Chicago, Ill.

REFRIGERATION

Repair and improve all refrigerators. New manual tells how. Charts and pictures to help you. Price only $1.00 postpaid. Money back guarantee. Supreme Publications, 328 S. Jefferson St., Chicago, Illinois.

MENTAL SCIENCE

Awaken Your Hidden Powers!

You are a sleeping giant. Learn how to release your unused forces. New, truly practical reading on everyday psychology. Teaches you self-mastery, influencing others, getting ahead, etc. We, a group of psychologists, Law or ob. Satisfaction guaranteed. FREE DETAILS, write today! Nelson Co., 321 S. Wabash Ave., Dept. 308, Chicago.

Piles—Fistula Facts

122-Page Book—Sent FREE

Do you suffer pain, torture and broken health of neglected Piles, Fistula, or related rectal and colon ailments? Write today for 122-page FREE Book. Learn facts. The McCleary Clinic, 1171 Elms Blvd., Excelsior Springs, Mo.

4 Painting-Size PIN-UPS Reproduced in Tru-Life Colors

4 BEAUTIFUL GIRLS

- The Bathing Girl
- The Boudoir Girl
- The Mirror Girl
- The Sunshine Girl

GET ALL 4 OF THESE

DIRECT FROM THE ARTIST

Masterpieces from the palette of George Petty . . . four different girls with the alluring, shapely figures that Petty has made famous . . . faithfully portrayed in rich colors by photo-lithography on heavy paper . . . large 7 x 11½ ft. in size . . . ready to frame or pin up . . . shipped to reach you fresh and unfolded . . . special packing used for overseas orders. . . . NOW obtainable anywhere else . . . your money back if you are not delighted . . . all four pictures for only $2.00 for the set, postpaid . . . supply limited, order today from—

GEORGE PETTY
1224 Mound Avenue
Racine, Wisconsin

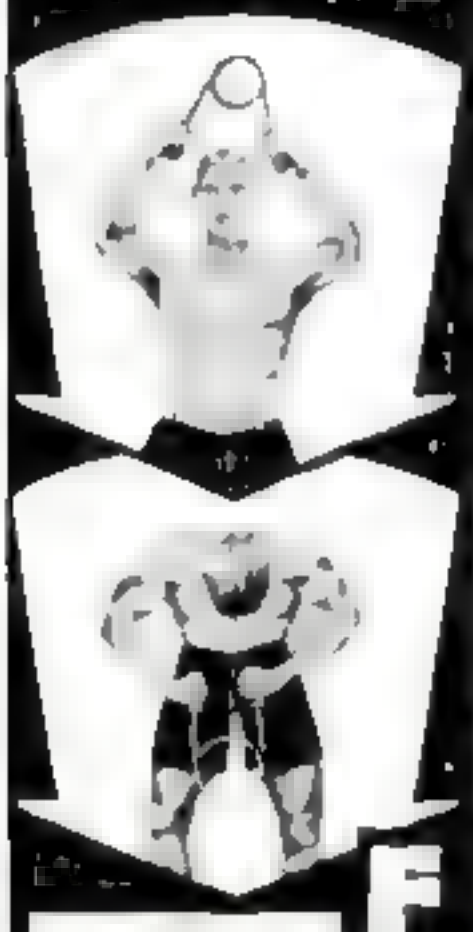
MAIL THIS PETTY GIRL COUPON

GEORGE PETTY
1224 Mound Ave., Racine, Wis.

I enclose $2 ☐ Money Order ☐ Check ☐ Cash for which please send to the address below 1 set of 4 Petty Girls

Name _____
Address _____
City _____ *State* _____

SUPER STRENGTH THROUGH THESE EASY STEPS



ADD INCHES TO YOUR BACK, CHEST, BICEPS

FREE!

WITH YOUR ORDERS SUPER POWER HAND GRIPS

SUPER POWER CRUSHER GRIP "Moulder of MEN"

DOUBLE MONEY BACK GUARANTEE

SEND NO MONEY

Just fill in and send coupon. When postman delivers your Super Power Crusher Grip and free Super Power Hand Grips, pay him only $1.98 plus postage. Develop champion strength as champions do. Rush coupon . . . Now!

MUSCLE POWER CO., Dept. 6211,
P. O. Box No. 1, Station X,
New York 54, N. Y.

Send me the Super Strength Crusher Grip as described. I will pay the postman only $1.98 plus postage. Also enclose the Super Power Hand Grips free with my order.

Name. _____

Address. _____

(SPECIAL) If you are aboard ship or outside the U. S. A. please send money order for $2.45.

Buy War Savings Bonds and Stamps regularly.

OSWALD RABBIT Cartoon Home Movies Are ALWAYS Funny!

Screen several OSWALD RABBIT animated Cartoons next time you entertain family and friends. Packed with laughable escapades. Show also an AVIATION feature for added thrills!

OSWALD FEATURES

Doctor Oswald	9A
Sniffs and Snuffers	10A
The Fatty and Express	11A
Adventures in Dreamland	12A
G Man Oswald	13A
Bo Peep's Sheep	14A

Above in 50 ft. 8MM at $1.25, and 100 ft. 16MM at $2.50

Cartoon and Aviation HOME MOVIES are the popular and ideal entertainment for parties. Get complete catalog today. Stage a HOME MOVIE show often!

Get at Your Dealers. Write for Catalog and Prices to:

HOLLYWOOD FILM ENTERPRISES, INC.
6060 Sunset Blvd., Dept. 116, Hollywood 28, Calif.

IT'S FUN TO MAKE THINGS—

and easy too, with the Guildcrafter's Home Study Course in Arts and Crafts. Practical suggestions for hobbies, toy and nursery decoration, party favors and prizes, greeting cards, etc. Easy to-follow directions, attractive suggested designs. It's a complete home study course for individuals or groups in handy, notebook form. Complete course, $6.00.

The American Crayon Company
239-339 Hayes Avenue Sandusky, Ohio

STAMMER?

"This new 124-page book 'Stammering, Its Cause and Correction,' describes the Bogue Unit Method, for self-correction of stammering and stuttering, successful for 42 years. Free—no obligation. Benjamin N. Bogue, Dept. 1855, Circle Tower, Indianapolis, Ind.

GET THIS FREE BOOK!

Class Pins and Rings

Artistic pins, rings and emblems. Finest quality. Reasonable prices from 55c up. Write today. Dept. G.
Metal Arts Co., Rochester, N. Y.

FREE Catalog

LEARN MENTAL TELEPATHY

STEP AHEAD OF THE CROWD!

ROCKET YOUR AMBITIONS into reality. Get things you want. Banish Fear, solve problems quickly! Free startling methods and experiments. Write TODAY for startling FREE booklet and convincing FACTS. Or send $1 for 5 amazing lessons and GREAT KEY THOUGHT. Atlantean Guild, Box 582 B, Harrisburg, Pa.

The Dennison Handy Helper Says:

"PLAN TO BUY U. S. WAR BONDS AND STAMPS REGULARLY ...AND STICK TO IT"

Dennison

GUMMED LABELS STICK TO IT, TOO

DENNISON MFG. CO., Framingham, Mass.

Learn to Mount Birds and Animals—Spend Coupon for Free Book!!

Fun—Fascination—Profits

Be a Taxidermist. All Secrets Revealed. Learn at Home

Save Your Hunting Trophies

Mount (stuff) expertly your valuable **game-birds, animals, fish, game-heads.** Preserve them just like **life.** That is Taxidermy. Learn at home by **mail.** Decorate home and den with nature's art. Make undreamed-of **profits** in spare time, in your shop. You can. Will you? Win fame as a taxidermist. Investigate. Mail **coupon** NOW.

FUN WITH A FEW LOADS

Yes. WAR makes shot-gun shells scarce. But just a FEW shells obtains a FEW DUCKS, and with TAXIDERMY, you will have the grandest hunting season EVER. Taxidermy is fine beyond description for MEN AND BOYS. Be one of our 300,000 students. We invite YOUNG MEN, boys, youths.

"Eat your trophies and have them too"

Wild Game Not Needed

Use **common** specimens, squirrels, rabbits, chicks, pets, owls, pigeons—even frogs. Make useful articles like those shown here. Mount them in human and humorous positions. This is craft and novelty taxidermy. It's **fun**—and **profitable.** All included in our unique lessons. It's **marvelous.** Write the school this minute.

BIG PROFITS From Your Shop in Spare Time

Many students earn from $40 to $75 monthly in spare time. Some earn thousands of dollars each year. Sportsmen bring their trophies to be mounted. Besides you can sell your own **Novelty** groups for homes, dens and for merchants' window display.

LEARN TANNING

The lessons teach tanning harness, sole, chrome leather, also furs. Expert methods. **Very profitable.**

Mail Coupon

Or a postcard will do. No obligation on your part. The beautiful **Book,** with hundreds of entrancing **Pictures is Free.** Don't miss your **Only Chance** to get this remarkable book **Free and Postpaid.** Write today. State your **Age.**

FREE BOOK

Northwestern School of Taxidermy,
3398 Courtney Bldg., Omaha, Neb.

Gentlemen: Please send at once, your free 64-page book on Taxidermy without any obligation on my part. Tell me how I can learn fascinating Taxidermy at home.

Name..... Age.....

Address.....

Northwestern School of Taxidermy
3398 Courtney Bldg. Omaha, Neb.

Add a Language To Your Assets by LINGUAPHONE

★ In War, in Peace, ability to speak another language is an asset which will tip the scales in your favor . . . open new opportunities, earn promotion.

Speak { ITALIAN, SPANISH, PORTUGUESE, RUSSIAN, POLISH, NORWEGIAN, FRENCH, GERMAN, JAPANESE

or any of 20 other languages

Quickly, easily, correctly by LINGUAPHONE Ear-Eye METHOD

This amazingly simple and delightful way to learn to speak any of 29 languages in your own home is the work of 150 of the foremost language teachers of famous universities.

You merely LISTEN to the voice of native teachers. Your EYES follow the text and illustrations . . . and before you are aware you are repeating the questions and answers as naturally as speaking with a native.

Endorsed by educational authorities, Linguaphone is used by Army, Navy, Flying, Signal, Medical Corps and other services; by 14,000 schools, colleges and by more than one million home-study students. Do not confuse Linguaphone Ear-Eye Method with any other.

Send for FREE book. Call for FREE Demonstration.

LINGUAPHONE INSTITUTE
55 RCA Bldg. • New York (20), N. Y. • CI 7-0830

WANTED

1000 High School Seniors

TO COME TO CALIFORNIA TO ENROLL IMMEDIATELY IN THE AERO TECH COMBINED AVIATION AND 4TH YEAR HIGH SCHOOL COURSE

Make the most of the next twelve months by finishing your fourth year of high school at Aero Tech where you can combine with it aircraft mechanics or engineering studies. Even though you may be back in high school, if you act now, you can still enroll in these courses.

GAIN A FULL YEAR OF AVIATION TRAINING

You will be doing far more for yourself and your country by combining your last year in high school with aircraft mechanics or engineering. Whether you go into military service or war industry at the end of your training, you will possess technical qualifications that will raise you above the average of others and open the door to specialized assignments.

APPROVED HIGH SCHOOL AND AVIATION COURSES

State Certified and CAA licensed instructors supervise your high school and aviation training. When successfully completed you receive your High School diploma in addition to your Certificate of Award covering your aviation course. If you combine the High School and the Master Mechanics Courses you would then be eligible to qualify for CAA Airplane and Engine license

ONE AND TWO YEAR ENGINEERING

You can continue your technical studies by taking the Aero Tech one or two year Aeronautical Engineering Course. Advance training in post graduate subjects and research is also available

YOU CAN EASILY TRANSFER

Merely secure a transcript of your grades and full credit will be given you when you enroll at Aero Tech

IDEAL LIVING IN CALIFORNIA

You will probably choose to live in Aero Tech's new dormitories adjoining the campus. Under the supervision of the Students Welfare Council, you will enjoy comfortable lodgings, wholesome food and real companionship.

SEND COUPON TODAY for Enrollment Application

AERO INDUSTRIES TECHNICAL INSTITUTE
3247 W. San Fernando Road, Los Angeles 26, Calif.

Gentlemen: Please send details and enrollment application on course checked below, without obligation.

Master Mechanics with ☐ or without ☐ 4th year high school
Aeronautical Engineering with ☐ or without ☐ 4th year high school
Special Aircraft Pre-induction with ☐ or without ☐ 4th year high school

NAME ..... AGE .....
STREET .....
CITY ..... STATE A-4-s

LEARN MONEY-MAKING CARTOONING

Home study method that has helped train creators of "Terry & Pirates," "Wash Tubbs," "Out Our Way," "Winnie Winkle," "Reg'lar Fellers," "Strange As It Seems," "Secret Agent X-9" and many others. Earn while learning. Rush 10c for Picture Chart to test your ability and full details. State age.

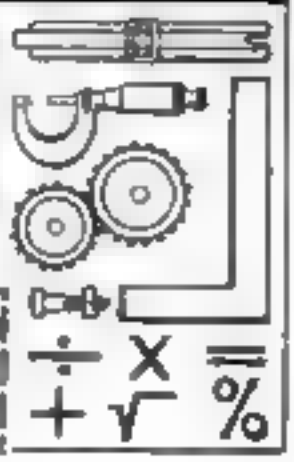
THE LANDON SCHOOL, 4231 National Building, Cleveland 14, Ohio

YOUR OPPORTUNITY!

TECHNICAL BOOKS of All Publishers for Free Examination. Write today for free copies of catalogues.
MODERN TECHNICAL BOOK CO., 55 West 42 St., New York 18, N.Y.

Short-Cut Mathematics COMBINED WITH Practical Mechanics Simplified

NEW 2-in-1 trade secret! Now you can learn the speedy, simplified system of calculation used by draftsmen, engineers, accountants, "master minds" on the stage. Learn easy way to multiply 4 figures by 4 figures without using old fashioned multiplication; add long columns of figures this 1 photographic method. Learn horsepower, slide rule, micrometer, logarithms, wood measure, pitch, etc., etc. Large illustrated volume complete with answers. Satisfaction or refund. Amaze friends with your magic-like mental powers.



FREE Complete details. . . mail coupon TODAY!

NELSON CO., 321 S. Wabash, Dept. L-364, Chicago
Please send free details about "Short-Cut Mathematics and Practical Mechanics Simplified." No obligation.
Name .....
Address .....

ELECTRICAL BOOKS shipped FREE

FOR EXAMINATION
MODERN ELECTRICITY
INCLUDING RADIO AND REFRIGERATION

Here's great news for anybody interested in Electricity. NEW 18th edition of Applied Electricity brought right down to date with NEW Electrical subjects fully covered including Electronics. Blue Print Reading. 10 big Volumes sent at once FREE for examination.

New Edition
FOR BEGINNERS AND EXPERTS

over 3,000 pages hundreds of illustrations the most complete work of its kind we have ever published. Dynamos, motors, power stations, wiring, house wiring, engineering, electronics, explained so anyone can understand it.

BIG FIELD! Big Demand! Big Pay!

Men who understand electricity are urgently needed in thousands of war production plants. Many planes, shipbuilding, armaments, machine shops, practically every industry, are calling for men and even a knowledge of this subject make big money. Pleasant, fascinating work, easy to learn and do. Learn with these books. Send coupon for a set for FREE examination and see for yourself.

SEND NOW A year's consulting privileges with our engineers now given to all buyers of this famous 6-vol. Encyclopedia of Electricity.

AMERICAN TECHNICAL SOCIETY
Vocational Publishers since 1898

American Technical Society, Dept. C820, Drexel at 58th St., Chicago 37
Send for 10 days' free use the 10 volume set of New 18th Edition Applied Electricity. I will pay the delivery charges only on the books I keep, and if I decide to buy the set I will pay $2.00 in 10 days and $3.00 a month until the total price of only $29.80 is paid. Also include one year of Consulting Service. If I return books I will pay nothing. If I keep them I will send $2.00 in 10 days and $3.00 a month until the total price of only $29.80 is paid. Also include one year of Consulting Service.

NAME

ADDRESS

CITY STATE

Please attach letter stating age, occupation and name and address of employer, and at least one business man as reference. Men in service, give home address.

Mechanically Inclined Men: HOME APPLIANCE REPAIRING Offers Big Money-Independence

America's War Made Industry

Restriction of manufacturing has meant that the men who know Home Appliance Repairing—fixing refrigerators, vacuum cleaners, washing machines, motors, welding, nickle plating, etc., etc.—are reaping a steady, daily stream of dollars and building for themselves a permanent profitable business.

No Previous Experience Needed

The ability to hold and use a tool plus an ambition to make money is all that you need to become a successful Repair Shop Owner.

Full Time or Spare Time

Work as many hours as you want. $5.00—$6.00 an hour often made.

New Course Tells All

Our new course on Home Appliance Repairing, profusely illustrated, shows you in simple, easy to understand language how to make all repairs, build tools you need and how to get business to come to you. Price of course is so low that your savings on your own household repairs will quickly pay for it. Send today for complete FREE literature on how you too can get started.

CHRISTY SUPPLY CO.

2835 N. Central Ave. Dept. D-1001, Chicago

TRI-STATE COLLEGE
B. S. Degree in 27 Months

Distinguished for technical 2½ year courses in Electrical, Mechanical, Chemical, Radio, Aeronautical Engineering, Business Administration, Accounting and Secretarial. Campus. MEN AND WOMEN. Give high school grades, with good record in math. Physics. Preparatory Department. Modern laboratories, latest equipment. Low tuition. Low living costs. Campus and student body. 60th year. Enter January, March, June, September. Write for catalog.

S113 College Ave. ANGOLA, INDIANA

6 SHORTHAND in WEEKS AT HOME

Famous Speedwriting System. 31st Yr. No Symbols — Uses Alphabet (ABC's). Over 100 words per min. easy. 100,000 Speedwriters in Business, Civil Service. Very Low Cost. Send for FREE BKLT. 30.

Speedwriting
274 MADISON AVENUE, N. Y.

The SUPER SYSTEM

of Natural Physical Training builds health and strength. Send for my free booklet "Building A Better Body".

HARRY GOOD, 3361-S WATSON RD., ST. LOUIS 9, MO.

Getting Up Nights Makes Many Feel Old

Do you feel older than you are or suffer from Getting Up Nights, Backache, Nervousness, Leg Pains, Dizziness, Swollen Ankles, Rheumatic Pains, Burning, scanty or frequent passages? If so, remember that your Kidneys are vital to your health and that these symptoms may be due to non-organic and non-systemic Kidney and Bladder troubles—in such cases Cystex (a physician's prescription) usually gives prompt and joyous relief by helping the Kidneys flush out poisonous excess acids and wastes. You have everything to gain and nothing to lose in trying Cystex. An iron-clad guarantee assures a refund of your money on return of empty package unless fully satisfied. Don't delay. Get Cystex (Siss-tex) from your druggist today. Only 35c.

Cystex
Helps Flush Kidneys

Listen to this Record!

SPEAK SPANISH

FRENCH, GERMAN, OR ITALIAN

Big opportunities awaiting Americans who speak Spanish. Learn as easily as a child learns—by listening to these brand-new CORTINA recordings.

Only 15 Minutes a Day

THOUSANDS have found it the most fascinating, most satisfactory method. Here is the quick, easy way to learn Spanish for PLEASURE AND BUSINESS. INVESTIGATE!

Sent on 5 Days Approval

"The Cortina Short-Cut" tells just what you want to know. Interesting. Get it.

Write Today—NOW!

CORTINA ACADEMY (Language Specialists for 60 Years)
Dept. 1211, 105 West 40th Street, New York 18, N. Y.

Please send me free—without obligation—your booklet, "The Cortina Short-Cut." I am interested in (mark)

☐ Spanish ☐ French ☐ Italian ☐ German

Name .....

Address .....

WHERE OUR WAR WORDS COME FROM:

Strategy means, literally, Leading an Army

STRATEGY comes from the Greek verb *strateúein*, "to be leader of an army." Both you and your children will enjoy the thousands of fascinating etymologies (word origins) in WEBSTER'S NEW INTERNATIONAL DICTIONARY *Second Edition*. It is truly the foundation book for home education! It tells you everything you want to know about words, 600,000 of them, 122,000 more than in any other dictionary. Mail the coupon today for free illustrated booklet of interesting word origins and ask any bookdealer to show you the *Genuine Webster*—the Merriam Webster—*identified by the circular trade-mark*. G. & C. Merriam Company, 364 Federal Street, Springfield 2, Mass.

Advt. Copyright by G. & C. Merriam Co.

WEBSTER'S NEW INTERNATIONAL DICTIONARY Second Edition

This Amazing Chart Makes TRIGONOMETRY EASY

Pocket Size

40 TRIGONOMETRIC EQUATIONS quickly found on TRIG-EASY CHART. All errors through use of wrong equations eliminated. Angles and dimensions accurately determined

Without Knowing Higher Mathematics

With this amazing TRIG-EASY Chart YOU quickly solve Trigonometry problems. War Workers! Math Students! Qualify NOW for big pay in Tool and Die—Machine Shop—Sheet Metal—Die Sore—Patterns—Layout—Inspection—Drafting Departments, etc. Prepare for a more important job in America's busy wartime industry. TRIG-EASY Chart is the short cut. Send only 50c (coin) for TRIG-EASY Chart with full instructions—MONEY BACK GUARANTEE.

QUALIFY FOR BIG PAY — EARN A RAISE

E. H. NEEDHAM (Trig-Easy) Dept. 1-L Culver City, Calif.
Dear Sir—Enclosed find 50c for Trig-Easy Chart and instructions

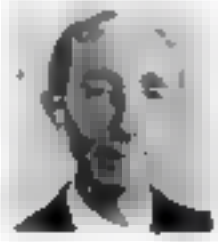
Name_____

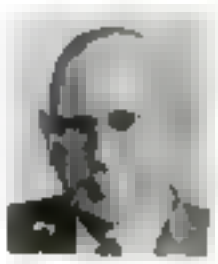
Address_____

City_____ State_____

HAVE THIS STAFF OF SPECIALISTS HELP YOU PATENT *your* IDEA

NO MATTER HOW GOOD your invention may be, the commercial value of your patent protecting that invention depends upon the careful preparation of strong claims covering it. This firm of Registered Patent Attorneys has helped and wisely advised individual inventors for almost half a century. Our staff is made up of specialists—men who are intimately familiar with those particular classes of inventions to which they devote their entire time. The object of this organization is to secure for its clients the strongest possible patents which their inventions warrant.





Present War Production

A GOLDEN OPPORTUNITY for Inventors

Don't forget—your patent will give you 17 years exclusive right to make, use and sell". Inventions adopted now as substitutes for materials and equipment not obtainable will have become regular articles of our daily lives when the Victory is won. The time to act—to protect your idea for immediate and future commercialization—is NOW!

Send at once for these Books

FREE Here are two plainly written books which tell you step by step how to safeguard your invention and how you should proceed on commercializing your patent. With these two helpful books we will send you a form for "Evidence of Invention". Don't delay. Get the coupon below into the mail AT ONCE!

VICTOR J. EVANS & Co.

Merlin M. Evans

REGISTERED PATENT ATTORNEYS
MAIN OFFICE: 740-M MERLIN BLDG.
WASHINGTON, D. C.

Please send me your books, "Patent Protection" and "How to Sell an Invention" without cost or obligation.

NAME_____

ADDRESS_____

CITY AND STATE_____

LET

Bernarr Macfadden

Help You

STRENGTHEN YOUR EYES

A Revolutionary Series Of Exercises

Are you bothered with eye strain? Like thousands of others, you may relieve overworked, suffering, tired eyes if you follow the advice of Bernarr Macfadden. *Remember Mr Macfadden, at 75 years of age, has perfect vision—needs no glasses!* Now you can know some of the secrets of eye strengthening he has discovered.

Entirely different—based on revolutionary principle, this course of exercises comes to you in a 28x22 in. chart in color, complete with easy-to-understand instructions. They'll amaze you with their beneficial results.

SOLD WITH AN UNCONDITIONAL MONEY-BACK GUARANTEE—ONLY $1.00

So sure is Mr. Macfadden that after a short time you probably will be able to see and feel tangible results from these exercises that he offers them to you with an unconditional money-back guarantee. If you are not satisfied, you may return chart within 10 days and your money will be refunded. AREN'T YOUR EYES WORTH A DOLLAR BILL TO YOU?

SEND NO MONEY

Merely pay the postman $1.00 plus 12c postage and handling charges. Or, if you send your check or money order of $1.00 with the coupon, we will be glad to pay postage.

MACFADDEN FOUNDATION, DEPT. 27
535 FIFTH AVENUE, NEW YORK, 17, N. Y.

Please send me Bernarr Macfadden's "Thousand Shift" eye course. I will pay the postman $1.00 plus 12c postage and handling charges.

I enclose $1.00 (check or money order).

Name

Address

City State

PATENTS

PERSONAL SERVICE

My Personal service assures strictest confidence on all your patent problems. Send me a model or drawing or sketch and description of your invention, and $5.00. I will make a search and report promptly as to its patentability and send you a copy of my 72 page booklet. Or, if you prefer to read my booklet first, write today for *FREE* copy. Registered Patent Attorney

L. F. Randolph, 340-D Columbian Bldg., Washington, D.C.

---

don't WORRY

ABOUT RUPTURE

Why put up with years of needless discomfort and worry? Try a Brooks Automatic Air Cushion. This marvelous appliance permits the opening to close, yet holds reducible rupture securely, comfortably—day and night. Thousands report amazing results. Light, neat-fitting. No hard pads or stiff springs to chafe or gouge. Made for men, women and children. Durable, cheap. **Sent on trial** to prove it. Never sold in stores. Beware of imitations. Write for Free Book on Rupture, no-risk trial order plan, and proof of results. All correspondence confidential.

BROOKS COMPANY, 160-C State St., Marshall, Mich.

AIRCRAFT Designing & Engineering

HOME STUDY AFFILIATE OF RYAN SCHOOL OF AERONAUTICS

You can learn to design airplanes. A Ryan Home Study Course in Aeronautical Engineering will prepare you quicker for a job with good pay and a future. Easy to understand. No experience necessary.

FREE 24 Page Valuable Illustrated Booklet

RYAN AERONAUTICAL INSTITUTE

4111 Lindbergh Field, San Diego, California

Inventions Wanted

Patented or Unpatented

Inventions can now be safely sold without patenting expense. If you have a practical useful idea for sale, either unpatented or patented, write today!

Chartered Institute of American Inventors

Dept. 3, 631 Pa. Ave. N. W., Washington, D. C.

PATENTS

AND TRADE MARKS

C. A. SNOW & CO.

Registered Patent Attorneys Since 1875

Write for Free Book and "Certification of Invention" form

427 SNOW BUILDING, WASHINGTON 1, D. C.

PATENT YOUR IDEAS

SEND FOR FREE BOOK → HOW TO OBTAIN A PATENT

Written by Former Member Examining Corps (1922-34) U.S. Patent Office

CARL MILLER, Registered Patent Attorney
Former Member Examining Corps U. S. Patent Office

Woolworth Bldg., Dept. 113 C New York · Bond Bldg., Dept. 113 C Washington, D. C.

Learn PHOTOGRAPHY at Home

Splendid opportunities. Prepare in spare time. Easy plan. No previous experience needed. Common school education sufficient.

American School of Photography

ARC WELDING *Pays Big!*

The HOBART School is a Non-Profit Institution

Founded to furnish industry with trained operators and to further the interests of arc welding the Hobart School from the beginning has been operating on a basis of the students sharing in material costs only. Nevertheless, the Hobart Course is an intensive one designed to prepare you for a big pay job as soon as you graduate. Individual booths welders let you get the most from the course. Learn the Hobart way for bigger pay.

Write for Further Details

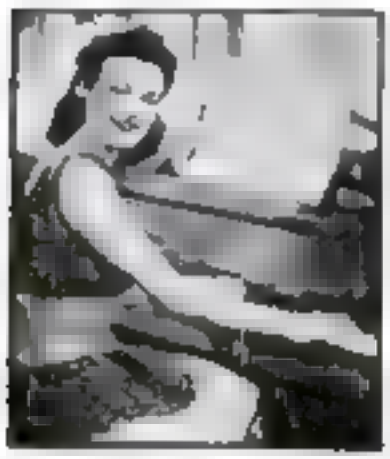
HOBART SCHOOL OF ARC WELDING, Box P-1131, TROY, OHIO

HOBART TRAINS YOU IN SIX WEEKS. A BIG demand for welders will continue after the war... Start now! Costs little.

FREE booklet

IMAGINE THEIR JOY WHEN THEY FOUND THEY COULD PLAY

This easy-as-ABC way:



LEARNED QUICKLY AT HOME

"I didn't dream I could actually learn to play without a teacher. Now when I play for people they hardly believe that I learned to play so well in so short a time." *H. S. C., Calif.

Plays at Dances

"Your lessons have been most satisfactory. I can play all of the popular songs. I have earned money playing at dances." *E. N. J., New York.

Plays on Radio

"I can't keep from telling you that I have a good position playing from KTHS Hot Springs, Ark., every morning." *J. S., Okla.

What Instrument Would You Like to Play?

JUST name your instrument and we'll show you how you can learn to play it—quickly, easily, in spare time at home. Never mind if you don't know one note of music from another—don't worry about "special talent." And forget all you've ever heard about music being hard to learn.

The truth of the matter is that *thousands now play who never thought they could!* Yes, men and women everywhere have discovered this amazingly easy way to learn music at home. Now they are enjoying the thrilling satisfaction of playing the piano, violin, guitar, saxophone or other favorite instruments. Some of them are playing in orchestras and over the radio; others are teaching music, making money in spare or full time. And thousands are having the time of their lives playing for their own enjoyment and the entertainment of their friends.

LEARN TO PLAY BY NOTE
Piano Guitar
Violin Saxophone
Organ Mandolin
Tenor Banjo
Hawaiian Guitar
Piano Accordion
Or Any Other Instrument

No tedious study and practice, no tiresome exercises. You learn to play *by playing*—start right in with the melody of a simple tune! It takes only a few minutes a day; the cost is trifling. Does it sound too good to be true? Mail the coupon and get the FREE PROOF!

FREE PRINT AND PICTURE SAMPLE

Fascinating illustrated booklet answers all your questions. Free Print and Picture Sample shows how method works. If interested, just mail coupon. U. S. School of Music, 811 Brunswick Bldg., New York 10, N. Y.

*Actual pupils' names on request. *Pictures by professional models.*

U. S. SCHOOL OF MUSIC
811 Brunswick Bldg., New York 10, N. Y.

I am interested in music study, particularly in the instrument indicated. Please send me your free illustrated booklet "How to Learn Music at Home" and the Free Print and Picture Sample.

Name _____
(PLEASE PRINT)

Address _____

Instrument _____ Have you Instrument?

A USEFUL XMAS GIFT!

AUDELS Carpenters and Builders Guides 4 vols. $6

Inside Trade Information

For carpenters, Builders, Framers, Building Mechanics and all Woodworkers. These Guides give you the short-cut instructions that you want—including new methods, ideas, plans, layouts and many helpful suggestions. An easy, practical way to use the approved and modern methods. A practical, every helper and Quick Reference for the master worker. Carpenters everywhere are using these Guides as a Helping Hand to Easier Work, Better Work and Better Pay. To get this assistance for yourself, simply fill in and mail the FREE COUPON below.

Inside Trade Information On:

How to use the steel square—How to file and set saws—How to build furniture—How to use a miter box—How to use the chalk line—How to use rules and scales—How to make joints—Carpenters arithmetic—Solving mensuration problems—Estimating strength of timbers—How to set girders and sills—How to frame houses and roofs—How to estimate costs—How to build houses, barns, garages, bungalows, etc.—How to read and draw plans—Drawing up specifications—How to excavate—How to use settings 12, 13 and 17 on the steel square—How to build hoists and scaffolds—skylights—How to build stairs—How to put on interior trim—How to hang doors—How to lath—lay floors—How to paint.

THEO. AUDEL & CO., 49 W. 23rd St., New York City

Mail Audels Carpenters and Builders Guides, 4 vols., on 7 days' free trial. If O.K. I will remit $1 in 7 days, and $1 monthly until $6 is paid. Otherwise I will return them. No obligation unless I am satisfied.

Name _____

Address _____

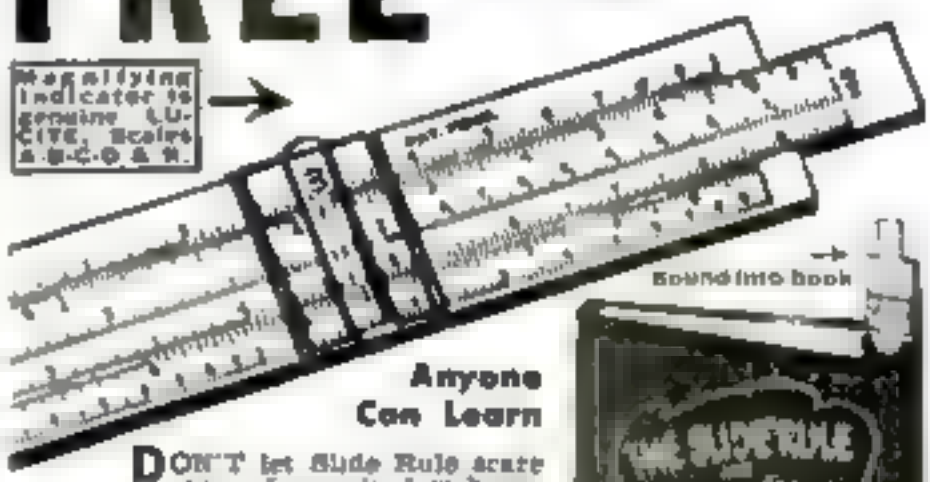
Occupation _____

Reference _____ PSM

---

10 INCH SLIDE RULE FREE

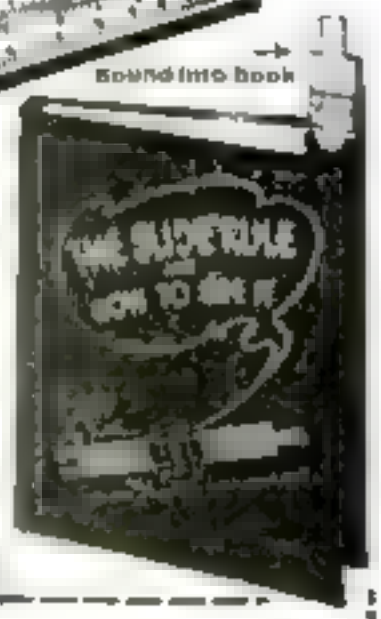
With Complete and Simple Instructions for use!



Anyone Can Learn

DON'T let Slide Rule scare you. Learn in few hours to do lightning calculations. Divide, multiply, find ratios, percentages, squares, areas, etc. Send name on coupon below for this wonderful course of instruction. "The Slide Rule and How to Use It" and get the 10 inch Slide Rule FREE with your course. Full price for course and Slide Rule both, only $3.98. Limited quantity! Rush your order!

WILCOX & FOLLETT CO., Dept. 311
1255 S. Wabash Avenue Chicago (5) Ill



WILCOX & FOLLETT, Dept. 311
1255 S. Wabash, Chicago (5) Ill.

Mail the new "Slide Rule and How to Use It" including work sheets, answer book and 10" Mannheim Type Slide Rule with Lucite Magnifying Indicator, all in one cover.

☐ I enclose ten dollars in full for $3.98.
☐ Ship COD, I will pay postman $3.98, plus charges.

Name _____

Address _____

City _____ State _____

The Greatest ENCYCLOPEDIA of FARMING

FACTS, METHODS, IDEAS, SHORT-CUTS, TABLES and PRACTICAL INFORMATION

Ever Packed Into One Volume!

35 FARM EXPERTS Show You How to Select and Operate a Small Farm for Security and Profit

IF YOU are hankering to enjoy the independence which only a farm can give, here is the book you absolutely need. A PRACTICAL GUIDE TO SUCCESSFUL FARMING was written under the editorial supervision of Wallace S. Moreland, by 35 outstanding authorities on modern farming enterprises, including POULTRY FARMING, DAIRYING, RAISING COWS, PIGS, SHEEP, RAISING VEGETABLES, TREE FRUITS, GRAINS and SMALL FRUITS, CHAIN CROPS, etc. Comprehensive sections on FARM FINANCING and MANAGEMENT, FARM EQUIPMENT, PEST CONTROL, SOIL CONSERVATION, etc. You get the latest methods of producing for profit. Here is the long needed, complete encyclopedia of farming for either beginner or veteran!

Over 1000 Pages 400 Illustrations

SEND NO MONEY Read 7 Days on Trial Just mail coupon. A copy will be sent you on approval. Examine the 400 pictures, read about what it covers, you then decide whether you wish to own it at the low price and easy terms. Garden City Publishing Co., Inc., Dept. 11PSM, Garden City, N. Y.

GARDEN CITY PUB. CO., INC.
Dept. 11 P.S.M. Garden City, N. Y.

Yes, send me A Practical Guide to Successful Farming on approval for 7 days free examination. Within that time I will either return it or send $1.95 as first payment, plus a few cents postage, and $1 monthly for two months until the special low price of $3.95 is paid.

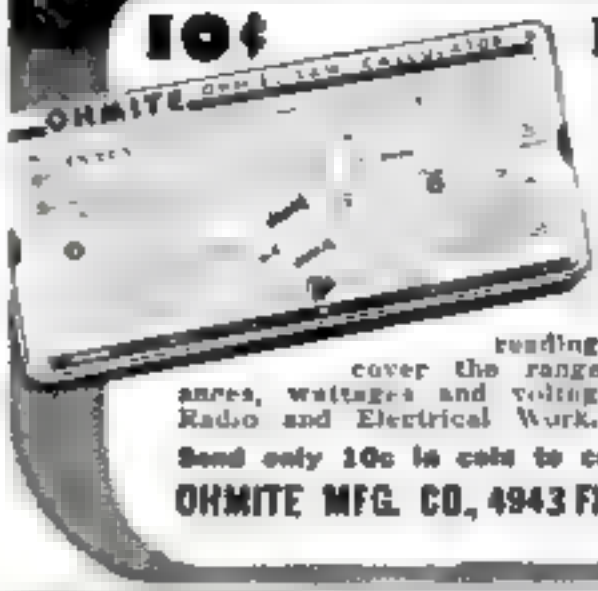
Mr.)
Mrs.) PLEASE PRINT
Miss)

Address

Occupation (If under 21) Age please

If you send $3.95 in full payment we pay postage. Same 7 day offer applies. Slightly higher in Canada—105 Bond Street, Toronto.

Get this Handy OHMITE Ohm's Law Calculator!



10¢

Figures Ohms, Watts, Volts, Amperes—Quickly, Easily!

Solves any Ohm's Law Problem with one setting of the slide. Requires no slide rule knowledge. All values are direct reading. Scales on two sides cover the range of currents, resistances, wattages and voltages commonly used in Radio and Electrical Work. Size 4½" x 9".

Send only 10c in coin to cover cost of handling.

OHMITE MFG. CO., 4943 Flournoy St., Chicago, Ill.

OPERATORS NEEDED

Make Big Money—Learn At Home

This book gives you detailed instructions for industrial and commercial spray painting essential to war production. Full information on pigments, thinners, varnishes, technique, spray guns of all types, tapes, finishes with a special section on WAR work. Easy to understand. Cloth bound. 135 pages—fully illus. Only $.50. Postage prepaid if cash in advance.

Order Today

FRED'K J. DRAKE & CO., Dept. PS11, 600 W. Van Buren St., Chicago, Ill.

Learn TOOL DESIGN

Quickly, quickly as Machine or Tool Designer through spare time home study. Many making $ 00 to $125 a week. Big demand. Industry calling for more machine and tool designers than ever before. Good pay jobs waiting. Rush name and kind of job wanted today for free facts.

OHIO INSTITUTE OF TECHNOLOGY, Box 128, Greenville, Ohio

THERE'S MONEY IN CARTOONS!

RAYE BURNS will teach you HOW to CREATE ORIGINAL CARTOONS at home that you may SELL. Course consists 26 lessons and over 400 illustrations. All for Only **$2.85**

Send name and address for free details.

RAYE BURNS SCHOOL, Dept. S, Box 1288, CLEVELAND 3, OHIO

STUDY ENGINEERING AT HOME

With A Chartered Educational Institution

Courses in ENGINEERING: Electrical, Civil, Mechanical, Drafting, Architectural, Steam, Aeronautical, Radio, Structural, Mining, Industrial, Highway, Petroleum, Marine, Chemical.
Courses in ARTS AND SCIENCES: Physiography, Education, Letters, Public Health, Medical Jurisprudence, Psychology, Sociology, Physics, Chemistry, Geology, Pol. Science, Theology, Law, Business and Commerce, Accounting, Mathematics, Statistics, Agriculture.

McKinley-Roosevelt Incorporated, 4610 BC, Sheridan Road, Chicago 40

NEW RADIO Made Easy

DO RADIO WORK IMMEDIATELY

Begin doing practical radio work with the first chapter. Use any ordinary home radio for many interesting experiments. Learn how to test, repair sets and parts. Schematic diagrams picture-clear explanations make basic radio knowledge easy to understand and to apply. This large manual is just like a complete course in radio. Helps make it for job and profit. Get a well paying radio war job, learn higher rank and pay in the Army.

GET PRACTICAL RADIO TRAINING

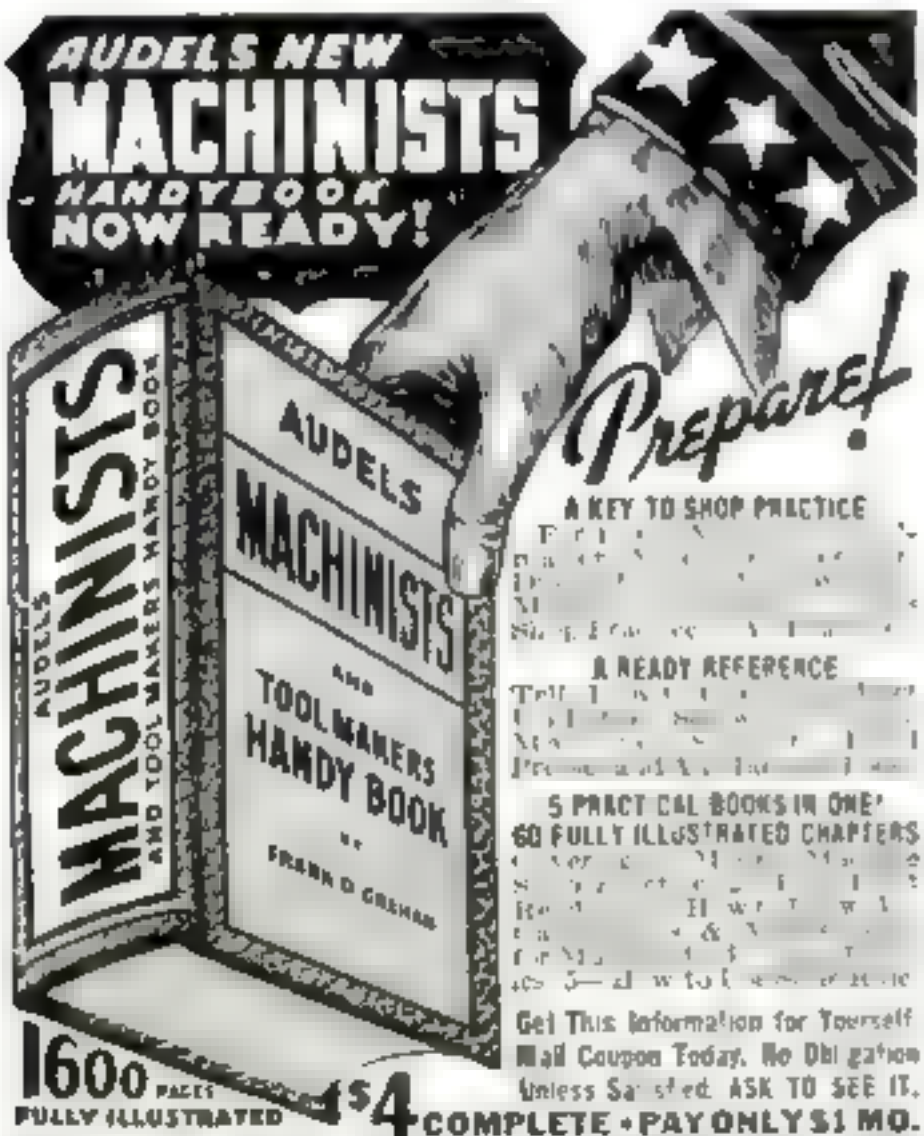
This amazing, different home study manual will teach you quickly to do radio work. At first you will learn about parts, tubes, trails, simple circuits. Later chapters cover receivers, transmitters, testers, trouble-shooting. New up-to-date 1943 edition, includes material on Electronics and Radar. Follows U. S. Office of Education outline.

NEW just out 256 large pages. Over 200 pictures. Manual is strong Leatherette cover.

SEND NO MONEY

Examine the complete *Practical Radio Manual* for 10 days, without risk or obligation. See how easy it is to learn radio this new way. Send no money. Simply pay your postman only $2.95 plus a few cents postage. You must be satisfied or your money will be refunded in full. Write today.

SUPREME PUBLICATIONS, 328 S. Jefferson St., Chicago 6, Ill.



A KEY TO SHOP PRACTICE

A READY REFERENCE

5 PRACTICAL BOOKS IN ONE! 60 FULLY ILLUSTRATED CHAPTERS

Get This Information for Yourself Mail Coupon Today. No Obligation Unless Satisfied. ASK TO SEE IT.

1600 PAGES FULLY ILLUSTRATED $4 COMPLETE • PAY ONLY $1 MO.

THEO. AUDEL & CO., 49 WEST 23rd STREET, NEW YORK

Mail AUDELS MACHINISTS & TOOL MAKERS HANDY BOOK. Price $4 on 7 Days Free Trial. If O.K. I will remit $1 in 7 days and $1 monthly until $4 is paid. Otherwise I will return it.

Name

Address

Occupation

Reference PSM

POPULAR SCIENCE Opportunities

ADVERTISING

MAIL-Order or agent ad reaching 1,000,000 families throughout United States $15.40 inch Newspaper, magazine, mailing-list, ratebook, free Chicago Advertising Agency, 20-SP West Jackson, Chicago

ADVERTISE newspapers magazines Publishers rates Mayton Agency 1107 Madison Avenue, New York City

ADVERTISE 25 words, 140 newspapers, $6.50 Lists Free Advertising Bureau, 6515 P Cottage Grove, Chicago 15.

AGENTS WANTED

START Your Own Business on our capital. Always your own boss Hundreds average $3,000 to $5,000 annual sales year after year. We supply stocks, equipment on credit, 200 home necessities. Selling experience unnecessary to start. Wonderful opportunity to own pleasant, profitable business backed by world wide industry Write Rawleigh Co., Dept. K-U-PSC, Freeport, Ill.

CALL On Friends with sensational Personal Christmas Cards 50 for $1.00 up Personal Stationery Assortment 24 Card $1.00 Assortment Profit 50c Experience unnecessary Samples on approval Wallace Brown, 225 Fifth Ave., Dept. B-35, New York

GOOD Paying Business Silvering mirrors, plating autoparts, reflectors, bicycles, bathroom fixtures, etc., by late method No tanks or shop required, outfit furnished Free sample Gunmetal Co., Ave. O, Decatur Illinois

EXCELLENT Business for Printing Salesmen Decalcomania Name Plates in small quantities. Also make money applying Initials on Automobiles Free Samples Raco, 1683 Washington, Boston (18), Mass

BIG Bargains for Big Fronts. Men's used pants 25c, suits $1.50, overcoats 50c, shoes 75c Over 400 sensational values Experience unnecessary. Free Wholesale Catalog Superior 1650-K6 Jefferson, Chicago

WHILE me and I will send you Four Samples of sparkling Christmas—New Year greeting cards and our 48 page catalog containing 50 other assortments with prices and full particulars absolutely free Paul H Peterson 3224 Parker Ave Edgewater Park

TAKE orders for new sensational Picture Lifetime Reproductions of any photo or negative. Amazingly beautiful Big earning opportunity Part or full time Outfit sent quickly Quaker Service Co., 814 Walnut St Philadelphia Pa

DISTRIBUTORS agents permanent connection established Automatic necessity No competition exclusive territory enormous profits Details Chamberlain Company 845 A Beachwood Los Angeles

AGENTS Coin Money It's New It's Hot! Everyone wants radiant plastic plaques of loved ones. Commissions advanced We deliver, Collect, Remit. Best 151 Upper Darby, Pa.

STRANGE Iron Shoe Polisher Sells like wild Replaces greasy paste liquids Simply glide over shoes Samples sent on trial Kramer 129 Akron Ohio

AGENTS 300% Profit Making Gold Leaf Window Letters, stores and offices Free samples Metallic Letter Co., 431 N Clark, Chicago

LICK After-war layoffs! Start own business home office Booklet describing "Conversion of 17" Tested Plans free Enterprise Co 3 4A Grand St New York

FREE Water and our concentrates, makes flavors lotions shampoos 12 products, labels bottles furnished Quasco, F-3003 Russell, Detroit

LUMINOUS Paint Ashtrays in Dark! Spectacular Dollar Seller Rush name for profitable details and free sample. Ward, 97B, Barbronk, Connecticut

SCIENTIFIC Manufacturing Processes Simplified Profitable Trade Secrets Profits to 1,500% Lists free. Thermoglab, Peoria 4, Illinois

PLAYING card game 250% profit Sample game 25c Box 841, Denver 1, Colorado

ANTIQUES, RELICS INDIAN GOODS

SWORDS, rapiers daggers, pistols, armor; illustrated catalog 25c Robert Abels, 860 Lexington Ave., N. Y.

25 GENUINE Indian Arrow heads, $1.00. Catalog. Geo. Holder, Glenwood, Ark.

AUTHORS SERVICE

BEGINNER WRITERS—Ten Basic Lessons 50c. Anderson, Vineburg, California.

NEW Writers Wanted to re-write ideas in papers, magazines, books Splendid opportunity to break into profitable Writing Send Rush postcard for Free Details. Comfort Writers Service, 210-R, South Seventh, 12, St. Louis, Mo.

AUTOMOBILES

NOTES On Automobile Ignition Systems Complete explanation of the many systems employed on all 1938-1942 automobiles. Includes complete number designations firing orders ignition timing procedure, terminal connections diagrams basic construction of equipment and principles of operation and specifications data for 1942 models $1.00 Postpaid Electrical Equipment Service Box 2-25 San Antonio Texas

WE BUY Late Cars $5 gives you prices, terms, full information, market per cent to allow by specific and reports in days time of sale We buy any make, year, condition Give auto make, year, John Hanley, 5719 Lonsdale, Detroit 8, Michigan

1943 IGNITION Supercharger, $1.50. Fast Starting, Mileage, Pep, BG Sales Mfg. Co., 60 John St., New York

AUTO SUPPLIES & EQUIPMENT

OPERATE cars, trucks, tractors, engines with wood or coal gas! Plans of gas engine extensively used in Europe, complete detailed information $1.00. P. M. Harris, Westby, Wisconsin.

ANTI Freeze noncorrosive, inexpensive, manufacture yourself. Send 30 stamp. Betag, Box 628, Borger, Texas.

AVIATION

ENTER my contest now Six flying courses and $1,000 worth of War Bonds positively given away Enclose dime for Details Division Flying School, Box 61AA, Simsbury, Conn.

BOATS, OUTBOARD MOTORS, ETC.

PLANS, also cut to shape boat patterns, blueprints 12 to 38 feet Illustrated "Build a Boat" catalog 10c (coin) "How to Build Boats" book, $1.00. Cleveland Boat Blueprint Co., Station A-77, Cleveland Ohio

MARINE Power Easily convert any Ford motor (domestic and foreign) with Osco parts and kits Complete catalogue 25c (coin) Osco Motors Corp 3437 N Lawrence St Philadelphia Pa.

BODY-BUILDING COURSES

SUPER Ju-Jitsu—lightning defense and attack system, Sensational new home study course now ready Learn to use brains to save your life with or w/o your bare hands Free details Nelson Co., 321 South Wabash Dept 3-308, Chicago

BECOME a Muscular Marvel. Body building course $2.00 Postpaid via Air Mail Pan American Academy of Physical Culture Box 2345 San Juan Puerto Rico

BOOK MATCHES

NOVELTY Matches Strike on Hitler's brushes or Jap Soldier Matches Strike 'Em Dead Specify 20 matchpacks. 18c postpaid Nipple'd Service, 3065 Rincon, San Francisco Calif.

MONOGRAM or name gold stamped on 50 matchpacks. $1.00 Postpaid Shepherd Service, 3065 Rincon, San Francisco Calif.

BOOKS, PERIODICALS

EDUCATIONAL Books sold cheaply or rented for small fee. Books bought Money back guarantee 4,000 Bargains Catalog Free (Courses Bought) Lee Mountain Pisgah, Ala

LIGHTNING Over The Treasury Building exposes the Money Trust. 160 pp. $1.00 Understand Money Meador Publishing Co 324 Newbury Boston 15 Mass

PETROLEUM Men Note Absolutely new prospecting method. Fifty page treatise Illustrating maps. Origin Of Petroleum, $1.00 D. Cyr La Vina Via Pasadena Calif

5c BUYS back-dated magazines. Foreign domestic, arts. Catalogs 10c. Cicerone's Magazines, 863 First Ave., New York 11, N. Y.

ADULT books Sample and catalog, 10c. Alstone, 388, Lunenburg, Mass.

RECEIVE $3.00 best-seller monthly selection, books for 75c on approval without obligation Kassin, 396 Broadway N Y C.

5 MOST read mail order magazines 20c. Armand Cartier 896B North, Pittsfield, Mass

THRILLING Free Book Offer Stamp brings details Variety House P O Box 56-B, Station N, New York City

BUILD IT YOURSELF

BUILD your tractor from second hand automobiles! Convert your horse drawn farm equipment in a tractor drawn equipment. Noonan's Garage, East Wareham, Mass

BUSINESS OPPORTUNITIES

PLASTEX Industries offer industrious men an opportunity to start a business of their own, manufacturing art goods, novelties and utility products in Plastex and marble imitation Inexpensive material makes regular 10c store seller Rubber molds furnished for speed production Small investment brings big returns We are now placing big chain store orders with manufacturers Ambitious men have chance for real prosperity Plastex Industries, Dept. S 1083 Washington Ave New York N Y

START Home Business making statuary plaques, art goods novelties, souvenirs, concrete pottery garden furniture, artificial marble flooring liquid marble Make your own flexible molds Amazing profits Valuable folder free Creative Publishers, Peru Illinois

LIQUID Marble, opaque white, multi colored Quarter Ounce Composition Plastic Like the wear Any color No plaster or Precious molds Plaster casting Get into the big money now Full information given free Write—Compo-Tex, Box 780 F St Louis Mo

GET Into Making Prepare for future. Start a decline business now Experienced operators immediately available Progressive Magazine tells how Free details and premium offer Progressive Mail Trade Sturgeon Bay Wisconsin

MECHANICALLY Inclined Men Own and operate general Appliance Repair shop Complete illustrated course shows you how Welding Refrigeration Motor repair How to get business etc all phases covered Free details Chicago Technical Dept 733 2835 N Central Ave Chicago

GOOD Paying Business Silvering mirrors, plating autoparts reflectors bicycles, bathroom fixtures etc by late method No tanks or shop required, outfit furnished Free sample Gunmetal Co., Ave E., Decatur Illinois

$25 WEEK to make money in home or office business of your own Full particulars free Elite Co., 314-A, Grand St New York

TOOL design pays big Home study course, Low cost Easy terms. Free booklet, Ohio Institute of Technology, Box 118 Greenville Ohio

LIQUID Marble — Marvelous colors! Brushed sprayed, molded Rubberistic molds Complete Production Plans! Full particulars free Marble Casting Service Edwardsville, Ill.

BOOKS, chock full of money making ideas formulas plans, information, literature free Ray 518 Third Ave. Montgomery, West Virginia.

GREATEST Non-Advertising Plan In Existence. Particulars 10c. Refundable with Plan. Hoffman, 3740 Coy, Cincinnati, Ohio

SWISS Music Box Works—$1.85 to $2.25 Suitable for many novelties Mermod Manufacturers, 147 West 46th Street, N Y

SUCCESS happiness assured regardless Free Reed Wizard Natick N Y.

CAMERAS, PHOTO SUPPLIES

WE Pay Top Prices for used cameras and photographic equipment. Turn your idle cameras, enlarger, printer, lenses, developing equipment etc into cash Just send us a List of what you have State make, model, age condition We will write you at once stating what we will pay Prepare your list today Send to Central Camera Co (Photographic Headquarters since 1899) 230 S Wabash Ave., Dept. J 182, Chicago Illinois

AMATEUR Photographers attention! Improve your hobby of picture taking and learn how to make money with it Write today for our 40-page book catalog and a sample copy of American Photography, enclosing ten cents for postage Contains articles and pictures of the world's foremost writers and pictorialists Camera House 141 383 Newbury St Boston Mass

MAKE money in photography Learn quickly at home Easy plan Previous experience unnecessary Common school education sufficient Booklet and requirements free American School of Photography, 1315 Michigan Dept. 174C, Chicago.

PHOTO Fans If you really want to get true results from your camera, send $1.00 for our enlarging and depth viewer Especially for colored photos. Zecco Specialties, Emporium, Pa.

BASS Says: War time proves Bass leadership. Amazing selection of finest still cameras Leica, Contax, Korelle Reflex, Argus new and used still available. Write for quotations. Satisfaction guaranteed or your money refunded. Bass buys and sells'em, trades'em. Bass Camera Company Dept. SP, 179 W. Madison St., Chicago, Ill.

OIL coloring photographs a fascinating hobby or profitable business. Learn at home. Easy simplified method. Previous experience unnecessary. Send for free information and requirements. National Art School, 1315 Michigan, Dept. 174C, Chicago.

CASH! Spot cash for cameras, lenses, movies or still, sound projectors. Send full description by mail, or wire for prompt cash offer. Over 30 years of dependable, insured honorable dealings. Bass Camera Company, 179 West Madison Street, Chicago, Illinois.

AT Last! Air and Light defying patented developers. Will not spot when used in the LT 30 soft working, LT 11 hard contrast. Quart 50c. Graphic Economy Developer Co., 1824 S. Trumbull, Chicago 23, Illinois.

CHEMICALS & APPARATUS

WINN'S new idea Home Laboratory Chemicals, Kits and apparatus outfits for home experimenting. Send 5c for literature and new supply catalogue. J. E. Winn Co., Dept. 611, 124 W. 23rd St., N. Y.

COLCHICINE Revolutionary chemical creates new mutant plants. Illustrated booklet plus Experimenter's Magazine 25c. Quantop Laboratory, Boston, Mass.

LABORATORY Spectroscope for chemical analysis $2.50. McCutting Sons, Campbell, California.

LABORATORY Catalog 25 Piece Chemical Set $1.00. 15 Chemicals $.50. Rankin Chemical Mfg., Kansas City, Mo.

286 PAGE Apparatus Catalog sent for 10c. 432 Page Chemical Catalog 25c. Laboratory Materials, 717 Vernon, Chicago.

DETECTIVES

DETECTIVE training. Secret investigations. Easy method. Fingerprints. Booklet Free. International Detective System, 1701-F Monroe N.E., Washington, D. C.

DETECTIVES—Work home. Travel. Experience unnecessary. Write, Wagoner, P-125 West 86th, N. Y. N. Y.

DETECTIVES needed everywhere. New training method. Write Hanna, 962 West Woodbine, Tampa 1, Florida.

DETECTIVE Training. Finger Print Secret Service. 1917-C North Kenneth, Chicago, Illinois.

DOGS, BIRDS, PETS

RABBITS. Flemish Giants, New Zealands. Reasonably priced. Franklin Young, Riverhead, Long Island, New York.

DRAFTING INSTRUMENTS

MECHANICAL Drawing Set: 9 Piece Complete [illegible] drawing needs. $4.25. Send for free complete catalog of drafting supplies. Gordon Co., 62-B Madison, Chicago.

EDUCATIONAL & INSTRUCTION

PSYCHOLOGY teaches about mind. Psychology teaches about power of mind over body. Why not learn to use powers of your subconscious mind? Study. Broaden your views or interest in yourself. What other investment can yield better returns? Department 8, Taylor School of Applied Psychology, Chattanooga 1, Tennessee.

PREPARE yourself now for a well paying radio position after the war. Obtain your FCC commercial radiotelephone and telegraph licenses through our home study courses. Well-known for the man who has forgotten higher mathematics. An easily read, easily understood course. Moderate tuition fee. Write for particulars. American Radio Institute, 44 East 23rd Street, New York, N. Y.

WELDING—Electric Arc. Learn quickly by actual practice at Hobart Welding School. Individual instruction at bare cost of materials used. 50c in stamps brings valuable welding lessons post paid and full particulars. Hobart Welding School, Box F-1132, Troy, Ohio.

GOOD Used educational books on all subjects bought, sold, rented, exchanged. Satisfaction guaranteed. Complete data in 64-page illustrated bargain catalog Free. We're Nelson Company, 321 South Wabash, Dept. 203, Chicago.

CLINICAL Laboratory Technicians in great demand. We train you in your spare time, in your own home. You can practice while studying. Write for free catalogue. Imperial Technical Institute, Box 973-B, Austin 5, Texas.

LEARN Drugless Therapy at home. Free literature. Diploma. Drugless Therapy Institute, Tama, Iowa.

RADIO Engineering, Broadcasting, Servicing, Electronics, Aviation, Marine & Police Radio taught thoroughly. All expenses low. Co-educational. Catalog free. Dodge Institute, Dept. 106, Valparaiso, Ind.

BE A Doctor. Learn chiropractic. Fast growing profession. Residence course only. Write for catalog. Texas Chiropractic College, San Pedro Park, San Antonio, Texas.

BECOME a Doctor of Psychology (Ps. D.). Teach secret of contentment, happiness. Solve mental worries. Free book. College of Universal Truth, 9461-A North Ashland, Chicago.

MAKE up to $25-$35 week as a Trained Practical Nurse. Learn quickly at home. Booklet free. Chicago School of Nursing, Dept. K-10, Chicago.

TOOL designing pays big. Home study course, low cost. Easy terms. Free booklet. Ohio Institute of Technology, Box 119, Greenville, Ohio.

LEARN Correct English. Complete course quickly makes you master of words. Literature free. Popular Service, 652 Rutledge, Charleston, S. C.

PROPHECY Club reveals FDR's name approximated by six prophets who described new Christ. Christ is here. Details time. Nichols, Box 85, Waltham, Mass.

EXCEPTIONAL Opportunity. Operate a Collection Agency-Credit Bureau. Quickly learned. Many make $5,000 yearly, up. Write Cole Associates, Syracuse, N. Y.

ACCOUNTING Quality quality interpersonal request. Free booklet. Adams School, 714 Ambassador Bldg., St. Louis.

ELECTRICAL SUPPLIES & EQUIP.

ELECTRIC Pencil Writes—Engraves all [illegible] $1.00 postpaid. Beyer Mfg., 6515-C Cottage Grove, Chicago 15.

FOR Motors, Welders, Generators. Other Electrical Items. Write LeJay Mfg., 821 LeJay Building, Minneapolis, Minn.

ENGINES, MOTORS, ETC.

WINDING Data, 225 motors, single and three phase, $1.00. Motor Data, Box 9031, Kansas City 3, Mo.

FARMS, OTHER REAL ESTATE

SEE the Highlands of Louisiana where winter brings no idle acres. Choice cut-over land at low prices with terms. Send for descriptive book, without obligation. Long Bell Farm Land Corporation, 507 R. A. Long Bldg., Kansas City, Mo.

STROUT'S Big Farm Catalog: 68 Pages describing hundreds of properties in 13 states from Maine to Florida and west to the Mississippi—many pictures, rock-bottom prices. Write today for this money-saving time-saving book. Free. Strout Realty, 255-ZB 4th Ave., New York 10, N. Y.

GOOD Farm Bargains, Washington, Minnesota, Montana, Idaho, Oregon, North Dakota. Dependable crops, favorable climate. Write for literature listing typical farms. State in which state. J. W. Haas, 130 Northern Pacific Ry., St. Paul, Minn.

60 ACRES near White River unimproved, poultry land, $.00 $5 down, $5 monthly. Free [illegible] and literature. Hubbard, 260 Grossman Bldg., Kansas City, Kans.

ORLANDO, Florida. 5 acres on paved highway. Good fruit and vegetable land, easy terms, free booklet. Dept. Y, Interstate Development Co., Orlando, Florida.

40 ACRES good land $200, $5.00 down, $5.00 monthly. R. W. Stewart, Inverness, Florida.

FOR THE HOME

AIR Raid Protection—Protect your home from incendiary bombs. Will extinguish one or 10 Pound package $2.75 P. O. D. Stewart, 611 Third Avenue, N. Y. C.

FOR INVENTORS

INVENTORS Learn how without obligation how to protect and sell your invention. Secure Free Record of Invention form for establishing date of your invention, and Free Book "Patent Guide for the Inventor", containing complete information about patent procedure and selling inventions. Delay may be costly. For prompt, confidential service—write to—Clarence A. O'Brien & Harry Jacobson, Registered Patent Attorneys, 21A-L Adams Building, Washington, D. C.

INVENTORS Patent your invention; send now for our new Free copyrighted booklet "Protect, Finance, and Sell Your Invention" and Invention Record form. This booklet guides the inventor from the first step toward patent protection to final profit making from his invention. Reasonable fees, convenient terms. Counsel McMorrow & Berman, Registered Patent Attorneys, 143-X Albee Building, Washington, D. C.

PATENT Your Idea! Write immediately for two free illustrated books, "Patent Protection" and "When and How to Sell an Invention." 48 pages of valuable information for inventors. No obligation. Address: Victor J. Evans & Co., 743-M Merlin Bldg., Washington, D. C.

INVENTIONS developed. Drawings made. Calculations computed. Models built. Good tools bought and sold. Clinton Davidson, 636 C St., San Diego, Calif.

INVENTORS New mil'ary and commercial inventions urgently needed by manufacturers. Write for particulars. Chartered Institute, Dept. 3-A, Washington, D. C.

HAVE you a Patent? Will manufacture on shares. Campbell, 278 Mt. Vernon, Detroit, Michigan.

NEW gland stimulating vitamin. Details accompany "Colchicine" offer. See "Chemistry".

TOOL manufacturer will purchase patent or patentable idea for Automotive tools. Tools, 212 Avenue C, Brooklyn, New York.

CASH for practical ideas and inventions. Mr. Ball, BB-9441 Pleasant, Chicago.

FORMULAS, PLANS, ETC.

AUTHENTIC Formulary 936 pages. Illustrated. 10,000 Money making formulas, recipes, instructions, substitutes. $2.00 postpaid or C.O.D. (Foreign $2.25). Catalog. Adams-Brown, Chestnut St., Mass.

FORMULAS—All kinds. Latest money-makers; literature free. Kemikal, Park Ridge, Ill.

NEW gland stimulating vitamin. Details accompany Colchicine offer. See "Chemistry".

FORMULAS. Latest best. Analysis. Literature free. E. Bellert, Engineering Bldg., Chicago 6.

101 REAL Money Making Formulas 25c postpaid. Sign Farmington, Missouri.

HAIR PREPARATIONS

USED by thousands of men for years. Pro-Ker, a rum-ot, tonic hair scalp preparation for Hair Care, Loose Dandruff, Scalp Itch, Natural Hair Groom. Not greasy, does not stain. Clean, fresh odor. No alcohol. Pre War formula. Developed by Charles Nesser, noted hair specialist and author of "Our Vanishing Hair". Over 1,000,000 bottles sold. Money-back guarantee. Big 10 oz. bottle $1.50 postpaid or C.O.D. Hair Products, 662 Madison Ave., New York City 17.

HEARING AIDS & REPAIRS

HEARING Aids, Repairs, and Batteries. Quick Service. Wholesale, retail guaranteed. Marshall Brown, 10 East Congress Street, Chicago 5, Illinois.

HIGHGRADE SALESMEN

ADVERTISING Book Matches. America's largest manufacturer of Union Label Book Matches. Fast selling Line. Large sales producing kit. Sample matches. Complete cut catalog. 37 cover combinations. Makes selling easy. Commission in advance. Super Match Company, 7930 Greenwood Ave., Dept. P-11, Chicago.

EARN your withholding tax and more, too, by giving us [illegible] hours weekly. No capital or experience required. Box 2, Winona, Minn.

HOBBIES, COLLECTIONS

BEAUTIFUL Transparent colors are already out for you. Ten blanks and tubes makes you ten articles. In each kit are instructions which are very easy to follow for finishing. Price of each kit, postpaid $3.00 or $2.75 C.O.D. Hand craft Shop, Box 71, Somerville, N. J. We issue no rain checks.

FREE Hobby Premiums—Send 5c for sample of our new Hobby magazine and others. Paramount Distributors, Box 864-R, Denver 1, Colorado.

BEAUTIFUL Stones removed from rings, etc., 100 assorted $2.00. Lowe's, Box M 311, St. Louis, Mo.

NEW gland stimulating vitamin. Details accompany Colchicine offer. See "Chemistry".

HUNTING

FREE! Full Guaranteed Bargain Catalog, featuring thousands guns and "Hard-to-get" items, send 25c (refunded with first order) for handling costs. Swap guns and ammunition, or Get Cash. (Name your own price.) We pay More and sell for Less because we handle thousands upon thousands of new & used guns from $5 to $500.00. All models, gauges, calibers, makes. We also buy, sell or trade Ammunition, Reels, Rods, Outboards, Binoculars, Cameras, Watches. Write describing what you have to trade or sell for cash. Money Back Guarantee. Backed by 50 years' fair dealing. Keen's Sporting Goods, Milton Klein, Pres., 3011 South Halsted, Chicago.

INVENTIONS WANTED

NEW Product Ideas—A reputable manufacturer will consider new patentable items (preferably of metal) for manufacture and distribution in the aircraft, automotive, marine, industrial, or household field. Ideas will be purchased outright or on royalty if accepted. Write briefly the nature and intent of your idea and if interesting, we will send complete instructions on how to submit full details for fair consideration. Address P. O. Box No. 6598, Philadelphia, Pa.

CORPORATION with production facilities and sales connections desires contracts with patent holders for extruded or fabricated plastic articles. Interested in manufacturing for patent holders or on a royalty basis. Will not consider articles for engraving. Plastics Trim Corp., 402 Mt. Vernon Ave., Columbus 3, Ohio.

INVENTORS. Have you a sound, practical invention for sale, patented or unpatented? If so write Chartered Institute of American Inventors, Dept. J-C, Washington, D. C.

CASH for Inventions—Patented, unpatented. Mr. Ball, BC-6441 Pleasant, Chicago.

INVENTIONS Promoted. Patented or unpatented. Write Adam Fisher Company, 183-A Enright, St. Louis, Mo.

INVENTIONS. Have you good patentable ideas? Write Mr. Meirler, 31 West 42nd, N. Y.

LEGAL DIRECTORY

MEXICAN Legal Matters promptly handled. A. Munos, 240, Juarez, Mexico.

MACHINERY, TOOLS & SUPPLIES

STEEL beam trammels for draftsmen, engineers, mechanics. Circular Free. Clay Corporation, Box B, Automotive Station, Buffalo, N. Y.

NEW catalog of over 1000 useful, profitable items, cheap. Illustrated. Free. Kansas City Salvage Factory, 611 E. Kansas, Kansas City, Mo.

TWIN Cylinder Air Compressors $12.95. Motors—all sizes. Hoffmann, 2740 Coy, Cincinnati 10, Ohio.

GRIND Drills Like Factory Attachment for Brace or Grinder. Cheap. Factory, 616 A East 11, Kansas City, Mo.

MAGIC TRICKS, PUZZLES, JOKER NOVELTIES

WORLD'S largest professional magic shop. Large 100 page catalog with latest tricks. To receive mailings send 10c for postage. Hindu Novelty Co., 220 W. 42nd St., New York.

MAGICIANS', Gamblers' secrets exposed. Cards, Dice, Punchboards, Slot Machine Catalog 10c. Book Co., Box 671, St. Louis 1, Mo.

HYPNOTIZE Anyone Quickly! Sure Fire Method $2.00. Mystic Sales, 7126 Puritan, Detroit, Michigan.

MILK GOATS

DAIRY Goat Journal, Dept. 368, Columbia, Mo. Monthly magazine crammed with helpful information, $1 yearly, introductory 6-month subscription 25c.

MISCELLANEOUS

MEDICAL Laboratory Technicians in great demand. We train you in your spare time in your own home. You can practice while studying. Write for free catalogue. International Institute, Box 973 S. A., Dallas, Tex.

REPRODUCE any snapshot on hankerchiefs, wood, leather, etc. Outfit $1.00. No stamps. Dissell Co., 4667 Rockwood Road, Cleveland, Ohio.

MODELS & MODEL SUPPLIES

SHIP models, kits and fittings. Complete line Fisher model yacht equipment. All Boucher, Fisher, Marine Model and Ideal Kits, fittings and blueprints at standard prices. Most complete stock in New England. James Blue & Co., Inc., 220 State St., Boston, Mass.

MOST complete illustrated Catalog "O-HO 00" Model Railroad Parts ever published. Send 5c for mailing. Selby, 1377 Clarke Ave., Dept. 6, Bronx, N. Y.

RAILWAY models complete line information catalogs. O Gauge 104 pages, 25c. HO 48 pages, 10c. Walthers, 269 Erie, Milwaukee, Wisconsin.

ENGINES, Planes, Hundreds Of Hobby Items. Catalog 25c. G H Q., Dept. ST, 40 E. 21st St., N. Y. 10, N. Y.

SHIP Models and each supplies. Complete large 64 page Catalogue 20c. Wm. Wild, 305 E. 63rd St., New York City.

MONEY MAKING OPPORTUNITIES

LEARN Metascience. Remarkable drug-less healing. No manipulation. No apparatus. Unbelievable simplicity and results. Inexpensive correspondence course. Write Metascience, De Land, Florida.

MECHANICALLY Inclined Men—Own and operate general Appliance Repair shop. Complete illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business, etc., all phases covered. Free literature. Christy Supply, Dept. 1433, 1835 N. Central Ave., Chicago.

MONUMENTS

MONUMENTS Direct Low Prices. Freight paid. Guaranteed. Free Catalog and samples. Write Granite-Marble Factory, 448 Oneco, Florida.

MOTION PICTURE & SOUND EQUIPMENT

8-16mm FILM SUBJECTS. Black and White and Color. Buy or Rent. Largest selection ever compiled. 50c to $100. Write for new Deluxe 1943 Catalog profusely illustrated! 25c (coin or stamps) refunded on first purchase. Hollywood Movie Supply, Hollywood, California.

GLAMOUR Newsreel No. 4. Monotones and beauty queens. 50 ft. 8mm regularly $2.00, only $1.00. 16mm 100 ft. $2.00. Large sample 8mm dime. Jenkins 392-A Elmira, N. Y.

MOVIES For Men! Travel, Comedy, Glamour. 8mm.—16mm. Lists free; with purchase or rental order, if requested. Keeley, 62 E. 13th, New York City.

"The Greatest Passion Play" in 8mm, 16 and 35 mm. Specify Sound or Silent. Rent or Purchase. Hemenway Film Co., 31-Z Melrose St., Boston 31, Mass.

NEW Movie Films Cheap! Free Price List. Ideal Co., Pleasantville, Pa.

SEND stamp for 16mm, 8mm catalogue. Sterling's, 670 Northampton, Easton, Pa.

MOTORCYCLES, BICYCLES & SUPPLIES

MOTORCYCLE Parts, New and used. List 10c. Ballak, 311 N. 9th, St. Louis, Mo.

MUSIC, MUSICAL INSTRUMENTS

SONGWRITERS! Send your poems for our offer and Free "Rhyming Dictionary". Phonograph Records made. Vanderbilt Music Studios, Box 112, Dept. 4-L, Coney Island, N. Y.

SONGWRITERS. Write for Free Instructive Booklet. Original Ops. Publishers, United Music Corporation, Dept. 31, Beverly, Indiana.

PLAY Hawaiian Steel Guitar like the dime for sample arrangements, home-study folder. Christensen Studios, 705 Kimball Hall, Chicago 4, Ill.

RECORDINGS Thousands. 1900 to 1943. Classics, popular. Itemize Wants. Josephine Mayer, Santa Barbara, Calif.

OLD STAMPS WANTED

I WILL pay $ 00.00 each for 1918 2c green Prexie stamps (near perfect centering) up to $1,000.00 each. Send 4c today for large price list. Other amazing prices paid. Vernon Baker, 18, Fremont, Ohio.

PATENT ATTORNEYS

INVENTORS Learn how to protect and sell your ideas. Secure Free Record of Invention form for establishing date of your invention—and Free Book "Patent Guide for the Inventor", containing complete information about patent procedure and selling inventions, giving illustrations of many successful inventions, over 150 basic mechanical movements. Delay may be costly. For prompt, careful service write Clarence A. O'Brien & Harvey Jacobson, Registered Patent Attorneys, 22B-L Adams Building, Washington, D. C.

INVENTORS Before disclosing your invention to anyone send for Form "Evidence of Conception". Attached are Government and Attorney's Fees and instructions. Sent free. Lancaster, Allwine & Rommel, 417 Bowen Building, Washington, D. C.

PATENTS Secured. Two valuable booklets, Patent Procedure and Wealth and How to sell an Invention, together with valuable "Evidence of Invention" form sent free. Write immediately to experienced patent counselors. Victory J. Evans & Co., 41-M Merlin Bldg., Washington, D. C.

INVENTORS: Send for free copy my 72-page book on patents. Reasonable terms. Prompt action. Confidential personal service. J. F. Randolph, Dept. 340-A, Washington, D. C.

INVENTOR'S GUIDE free, containing 100 mechanical movements, information about patenting, selling, etc. Frank B. Lederman, 154 Nassau St., New York.

PATENT Particulars" and Blanks, free airmailed. Sterling Buck, F-Hotel Plaza, Washington, D. C.

PATENTS

WANTED At Once! New Inventions. Cash or Royalty. Finley Brothers, 1904 Woodbine, Knoxville, Tennessee.

INVENTORS Farsighted manufacturers already planning post-war use of new item military products. If you have a useful invention, patented or unpatented, write Chartered Institute of American Inventors, Dept. J-B, Washington, D. C.

PERSONAL

HAVE You Tried God? God never fails those who know how to apply the Creative God Law in attaining Health, Love, Financial Success. If you are troubled with ill health, financial or domestic difficulties, learn how to overcome these problems through the Creative Power of God, Here and Now. Write today for Free copy of "Your Heritage". The Neotarian Fellowship, Desk 31, Kansas City 8, Missouri.

PSORIASIS Sufferers: Piasmol has brought relief when everything else failed. Caution use as directed. Apply after bath, dries quickly, convenient. Try regular $1 bottle at (cost less than a cent) Write Piasmol Lab., Box 1268, Cleveland, Ohio.

ENTERTAIN Yourself by friends by Crystal Gazing and other forms of Mental Physical Phenomena. Instructions $3.00. Regular $1.00 1944 Astrological Forecasts sample 20c. Matpuboo, 3513 Prospect, La Crescenta, California.

FOOT Sufferers! Send 25c for trial size package Karbo-Kay that relieved me after 10 years agony of bad smelling sweaty Athletes Foot. You must be satisfied! Foot Clinic, Box 185, Pine Bluff, Arkansas.

CONSTIPATED? This drugless Method is guaranteed to clean you out. No laxative. No exercise or additional cost. Send 25c to The Health Counselor, Box 1311, San Francisco 1, Calif.

LIVE at home and operate Mail Order Business. Work Home People. Learn the Real Mail Order and Business by doing. Only $ 00 Postpaid. Mercer Co., Main Ave., Passaic, N. J.

BUY wholesale and razor blades, tooth paste, shaving cream, personal necessities. Free catalog. Kenmore, 71 Fifth Ave., New York, New York.

SONGWRITERS write for free booklet of Profit Sharing Plan. Allied Music, Dept. 00, 204 East Fourth, Cincinnati, Ohio.

44 ENGLISH Desk Calendars. Twelve Varga Girls. Sun-Esquire Agency, 1918 Girard, Philadelphia, Pa.

HANDWRITING character analysis, 25c. Graphologist, 38-B Woodbury Street, White Plains, N. Y.

PHOTO FINISHING

IMMEDIATE Service. Prints returned same day order received. Smashing Low Pre-War Prices! Sixteen guaranteed Deckled-Edge Velox prints from roll 25c. Or one colored or two plain enlargements Free with 8 Deckled Edge prints, 25c. 16 reprints from negatives 25c. Candid Rolls developed. Mag-Kote Tinted, Vignetted and processed in 1 hour 4 cents. Deckled Edge Velox Paper. 16 exp. 35mm $1.00. 16 exp. 60c. 8 exp. No. 127, 50c. 8 exp. Bantam, 25c. Reprints 2 x 4 Jumbo. We have a new perfect 35mm film. Low prices. Free Mailers, details on request. American Studios, Dept. 4C, LaCrosse, Wis.

BIGGEST $1.00 value in 35MM finishing today. 36 exposure fine grain developing, enlargement, deckled embossed margin and date. Eighteen exposures 50c. Sixteen exposure 35c. Free mailers. 8 exposure roll in beautiful deckled contact finish with embossed wide margin 25c. Mailbag Film Service, Box 5442-A, Chicago 80.

OIL coloring photographs a fascinating hobby or profitable business. Learn at home. Easy, simplified method. Previous experience unnecessary. Send for free information and sample. National Art School, 1115 Michigan, Dept. 3JC, Chicago.

YOUR choice of 8 parking prints or 8 oversize prints (deckle edge if desired), or 8 prints and two beautiful 5x7 enlargements for 25c. Dept. 200, Main Photo, LaCrosse, Wisconsin.

ROLL Developed, photo album & enlargements, 8 prints, 25c. Geppert Studios, Dept. 21, Des Moines, Iowa.

POULTRY & SUPPLIES

YOUR greatest poultry problem will look simple when you read American Poultry Journal regularly. 500,000 poultrymen do, why not you? Only 25c year, 5 years $1.00. American Poultry Journal, 520 S. Clark, Chicago.

ALL the News of poultry. Marketing, diseases, breeding, feeding, housing. Subscribe now. One year 25c, 5 years $ 00. Poultry Tribune, Dept. 193, Mount Morris, Ill.

PRINTING, MULTIGRAPHING, MIMEOGRAPHING, LABELS

DISTINCTIVE Stationery at Reasonable Prices. Samples Free. Stump Printers, South Whitley, Indiana.

PARCEL Post Shipping Labels printed two colors including your four line return address, size 3 1/2 x 2", 200 $1.00, 500 - $1.60, 1000 $2.75, 2000 $4.50 postpaid. Sample Free. The Edgewood Press, Box C-167, Edgewood Station, Providence, R. I.

1000 6 x 9 CIRCULARS for $1. Armand Cartier, 695 North Pittsfield, Mass.

1,000 EMBOSSED Business Cards $2.00. Goodall, 37 Gardner, Vallejo, Calif.

PRINTING OUTFITS & SUPPLIES

AUTOMATIC Post Card Printer Prints 3000 per hour at a cost of 3c per thousand. Simple to operate. Guaranteed. Price $9.50. Literature Free. L. M. Mc-Kown, Dept. PS, 507 E. Trade St., Charlotte, N. C.

"PRINTOMATIC" Self-feeding Rotary Stencil Post Card Printer, $9.50 Complete. All Makes Duplicator Supplies. Literature Free. Imperial Supply, 336 Fourth Avenue, Pittsburgh 22, Pa.

PRINTING Outfits and Supplies. Send stamp for drawings and data for complete illustrated supply book. Kelsey, Inc., W-4, Meriden, Conn.

PRINTER'S Monthly Bargain Catalog. Send stamp. Bradshaw, 3316-P Huron, Chicago 24.

PRINTING Presses, Type, Supplies. Lists 3c. Tarrant Service, Lewistown, Pa.

PROFITABLE OCCUPATIONS

MECHANICALLY Inclined Men—Own and operate electrical Appliance Repair shop. Complete illustrated course shows how. Welding, Refrigeration, Motor repair. How to get business, etc., explained. Free booklet. Write Chicago School, Dept. 1033, 2215 N. Crystal Ave., Chicago.

LOCKSMITHING Course. Practical instructions, lessons for handy men. Just out! Fit keys, pick locks, do code, master systems. Methods guaranteed. Send for Free Details. Nelson Co., 321 South Wabash, Dept. 108, Chicago.

$5000 FROM Half Acre! Growing Ginseng Seed, contract supplied. Particulars 10c. Associated Growers, Dept. 12, St. Norbert, Manitoba.

RADIO SUPPLIES & INSTRUCTION

RADIO Service men and experimenters send for our giant radio catalogue. Save dollars. United Radio Co., 1000-V, Newark, N. J.

LOWEST Prices. Radio Tubes. Parts. Free bargain lists. Potter, 1314-A McGee, Kansas City, Mo.

CRYSTAL Radio Experimenters. Write Hi Set, 28 E. 29th, New York.

RARE COINS

FREE! Foreign coin, banknote and Coin Collectors' Illustrated Catalog to approval service applicants. Send 3c postage. Up to $50 cash paid for Indian head cents. Also dates wanted. Buying list 10c. Tatham, Springfield 3, Mass.

WE buy Large Cents, Indian Cents, Old Rare coins wanted. Highest prices paid. Send 10c today for new 1943 price list. Numismatic Co., Dept. 4, Transportation Bldg., Chicago.

1943-P,S,D STEEL Cents, 5c each. 25 different Indians, $1.10. Thousands coins wanted, highest prices paid. Lists 3c. Bebee Coin Company, 1180 East 63rd, Chicago.

10 INDIAN Head cents, different dates, also pricelists, 35c. Schultz, 1081½ Richwood, Cincinnati, Ohio.

HOBBY News with large premium 25c a year. Keim, Box 103, Sta. A, Flushing, N. Y.

1943 D and S Cents, price list Mexican coin and bill, all for 15c. Ralph Hirschberg, 23 Waverly Ave., Oceanside, N. Y.

REFRIGERATION

REFRIGERATION and air conditioning. Time to earn dollar a day is headed for one of biggest peace time money making booms. Thousands of new servicemen and dealers will be needed. Be ready to cash in on new opportunities ahead. Get acquainted with the industry through reading Air Conditioning & Refrigeration News, $4 per year, 52 issues. Write Business News Publishing Co., Dept. 1113, 5229 Cass Ave., Detroit 2, Michigan.

REPAIR Refrigerators. Complete Manual, $1.00. Supreme Publications, 328 South Jefferson, Chicago.

RUBBER STAMPS

ONE line 15c, 2 lines 25c, 3 lines 35c. Excello, Box 500, Shreveport, Louisiana.

ONE Line 15c, 3—25c, 3—35c, 6—45c. De-Luxe Stamps, Auburn, Nebr.

CUSHIONED, 2 lines 45c, signatures $1.00. Federich Mfg., East Pittsburgh, Pa.

SONGWRITERS

SONGWRITERS! Outstanding, amazing offer. Hibbeler, C15, 3127 N. Avers, Chicago.

SONGWRITERS! Send your poems for our offer and Free Rhyming Dictionary. Phonograph Records made. Vanderbilt Music Studios, Box 112, Dept. 6-L, Coney Island, N. Y.

SONGWRITERS: Our service includes free records, melodies written, band or orchestra arranging and complete lead sheet copy, etc. Columbia Song Company, Box 670B-J, Beverly Hills, Calif.

SONGWRITERS! Send Poems For Immediate Examination and Free Rhyming Dictionary. Richard Brothers, 46 Woods Building, Chicago.

POEMS Wanted For Musical Setting. Send poem for immediate consideration. Free Chart. Music Masters, 648 Beacon Building, Boston.

SONG Poems Wanted. Write for Free Instructive Booklet, Outlining Opportunities. United Music Corporation, Dept. 24, Beacon, Indiana.

SONGWRITERS: Write for free booklet. Profit Sharing Plan. Allied Music Company, 204 East Fourth, Cincinnati, Ohio.

SONGWRITERS—Write today. Free booklet, Joan Song Service, 113-J West 44th, N. Y.

SPORTING GOODS, GUNS, FISHING TACKLE, ARCHERY

BOWS, Arrows for Horse or Hunting. Fishing Beautiful Archery in Color in book 90 pages. 80 illustrations only 10c. Illustrated catalogue Free. Archery, 617 S. Michigan, Chicago.

LEAD Guns Wanted, bought, traded, sold. Ammunition bought. Highest Cash Prices Paid. Singer Arms Corp., 507 5th Ave., New York, N. Y.

SEND for free illustrated catalog of Leather leather belts, pistols, gun cases and other sporting equipment. George Lawrence Company, Portland, Oregon.

ARCHERY Equipment. Catalogue Free. Mid West Archery, 2300-D East 75th, Chicago 49.

SEND 10c for list 100 used Guns. Praymeh's, Willmar, Minn.

STAMP COLLECTING

FOUR Years Of War reviewed in our 134 different stamp sets. Nazis as Heirs, conquest of Poland, Scandinavia, Holland, Belgium, France, Balkans, Libya, World across Russia, Japs back 20 open accounts, Pearl Harbor, Imperial sets, Corregidor, MacArthur's Retreat, Philippines Reoccupied, Race, African Colonials, Wake, Guam, Pacific, Caucasian, Solomon's, Offensive, Pacific Islands' Allied Bases, Free French, Axis Surrenders, Mussolini Exhibition, Allied Bombers Blast, German Pictorials and even Curacao's Striking New Issue catalogue $3.16—to new approval applicants only. Intercity Co., Dept. Y, Fort Washington, N. Y.

VICTORY Packet Free. Includes stamps from Turkey, Russia, British Colonials, Africa, Europe, Rehabilitation, Latin American, Asia; Map Stamps with Big Catalogue, also send for our approvals. Ozark Stamp Company, Dept. PR, Toronto, Canada.

FIND Stamps With Perforations Key Plate Errors, Giant Count Coils, Parcel Dater, Overprints, Packet Mixtures, Rotary Press, Coil Joins, Booklet panes, Big Price Reduction Lists, Colonials, Hinged Sets, Omnibus Issues, Triangulars, Jubilees, Commemoratives, Surcharges, Unused Values, Illustrated Albums, Hinges, Perforation Gauge, Watermark Detector, Duplicates Exchanged, Approvals. Mail Stamp Co., Department D, 56 E. Camden, New York.

WOW! $100.00 Worth of Fun for only 10c. 50 Foreign Stamps mounted and unposed, mostly on bits of paper, just as received from the church missions and other sources. Africa, So. America, Australia, China, Philippines, Dutch Indies, and other countries are represented. Includes a few commemoratives, airmails and stamps catalogue up to 25c or more each. This biggest Package of Fun in Stampdom and you might find something really valuable. Price only 10c to get an approval applicant. Money back if not delighted. Jamestown Stamp Co., Dept. No. 5, Jamestown, New York.

POSITIVELY Greatest Free Offer—Latest Scott's International $4.00 Stamp Album, interesting entire World, contains 24,000 illustrated descriptive spaces for 1943 Standard $3.00 Catalogue, Philatelic Encyclopedia, also 64 Free to applicants for Foreign Approvals becoming customers. Barton Stamp Service, Palm Springs, California.

BRITISH Empire Collection: Burma, Cyprus, Gambia, Solomon Islands, Tasmania. Also 50 other British. Only 5c with Pictorial and Commemorative Approvals. Lyman, Pittsburg, New York City.

$1.00 (Cat. Price) for 10! Two mint U. S. A. net 20c, queer countries packet (Obock, Manchuria, etc.) scarce set Russia cat. 50c. Everything for only one cent to approval applicants. Garrison Stamp Company, Box 416, Canaan, Maine.

FINE Approvals freshly mounted. Personal service. Tell me what countries you prefer and I'll send their stamps. Milton Skinner, 345 East Ocean, Long Beach, Calif.

FREE! Complete United States stamp catalog with 1,000 illustrations! Send 3c for postage. Harris & Co., 80 Transit Building, Boston, Mass.

70 DIFFERENT including Tannu, Australia, Indo-China, set approval applicants. Ransom, 1113 Pontiac, Ann Arbor, Mich.

UNITED STATES approvals complete coverage, fine quality, scarce to prices. Send 3c stamps. Box 436, Coconut Grove, Florida.

SPECIAL Airmails—23 different, including Zeppelin, Alaska, etc., to approval applicants. Continental Stamp Co., Dept. C, Sandy Hook, Conn.

FREE Canadian Set, Royal Visit, George VI Centenary Confederation Jubilee Others to approval applicants. Essex, Box 116, Passaic, New Jersey.

FREE Your choice of any 10 stamps from our U. S. Approvals. Send for illustrated list included. Cosmopolitan Stamp Company, 487 Broadway, Dept. 6P, N. Y. C.

SOLOMON Islands, Seychelles, Mafia, Caymans, Mashonaland, Bruce Everything new, approvals. Viking, 130 (P) Custer, Buffalo, N. Y.

50 DIFFERENT United States, $1 with Approvals. Beckman, Box 145-P, Maplewood, N. J.

UNITED STATES—Numbers 220, 278, 280, 297, 398, 647, 694, 695, 696, 741, F1. Send 30c. Whitton Stamps, Westport, Conn.

U. S. POSTAGE Duo Set, 1c to $5.00 value—10c. Lincoln Exchange, 173 Columbia, Irvington 11, New Jersey.

MEXICO Obligs Commemoratives Net Free with approvals. Pasdon Stamps, 1711-S Idaho, Toledo, Ohio.

1 LB U. S. Mixture 33c, 32 page list. Newhouseman Stamp Co., 1122 Pine St., St. Louis, Mo.

SAVE! Buy new foreign stamps as they are issued. Information Free. Raymond Koch, Missoula, Montana.

STAMP Dividends. Details with approvals. Armstrong, 60 Jeanette, Youngstown, Ohio.

PHILATELIC Shopping News (stamp bargains) Free! 3460 Rochester, Detroit, Mich.

BOOKS about stamps. List Free. Minis, 51 West 44th, New York 19.

APPROVALS. Theodore Nelson, 189 Steele Road, West Hartford 7, Conn.

10 STAMPS on 5c Approvals. Ryan, Pine Street, Middletown, Conn.

1000 MIXED U. S. Old and New 30c. 2 lbs. $1.00. Weatherby, Troy, Ohio.

TOBACCO—PIPES

ROYAL Deluxe Queen size cigar $2-1 Imported Long Havana Fillers guaranteed. Mild good cigar. A cigar worth 10c for 5c each. Send for free catalog and Special Offer. Sidney Ram, 30 West Monroe, Chicago 3, Illinois.

FREE To Pipe Smokers. For a new pipe smoking thrill and experience, try our brand of tobacco and get Free package Mild, Tasty Nature-Flavored "Green River". Write today. Pete Moberly, Box 569, Owensboro, Ky.

TRAPPING

TRAP Fox and Coyote, on bare grounds or deep snow. Learn modern methods and tricks to outwit the sly furbearers. Free illustrated circular. Q. Bunch, Welch, Minn.

FOXES 3 in one day. Trap all furbearers. Particulars Free. Guaranteed. Write—Estabrook, Sherburne, Vermont.

WANTED—MISCELLANEOUS

CASH for used optical, mechanical, scientific instruments. Gordon's, 183-85 Madison, Chicago.

MERCURY (Quicksilver) we pay $1.50 per pound. Western Metal Co., Bloomington, Illinois.

WELDING, SOLDERING

BUILD a arc welder without rewinding armature. Plans $1.00 each. 21 to 400 amperes from Vehicle motors. Light plant generators, Automobile starter generators. Welders Club, WB 1413 M-Mart, Chicago 54.

COAT electric welding rods 1c lb. Weld white metal (Di-cast). Make brazing flux. Plans, $1.00 Circular. Phillip Wilson, 1341-A E St., Napa, California.

Can a man have "Oomph"?

___ SURE

Pipe Appeal

PIPE APPEAL—Prince Albert! Pleasing *fragrance* to keep her smiling. *No bite—mildness* to keep *you* smiling. Rich taste, yet so easy on your tongue. Crimp cut to pour, pack, and draw *smoothly*, and help a pipe to cake up better. Better tobacco—world's largest-selling brand. Prince Albert for PIPE APPEAL!

PRINCE ALBERT

BUY WAR BONDS AND STAMPS

50 pipefuls of fragrant tobacco in every handy pocket package of Prince Albert

70 fine roll-your-own cigarettes in every handy pocket package of Prince Albert

Planes Back Up Ground Forces in

OUR NEW THEORY OF AIR POWER

BATTLES ARE NOW FOUGHT IN THREE DIMENSIONS AS FLYERS LEND SUPPORT WITH BOMBS, GUNS, AND CAMERAS

By JOHN H. WALKER

ALLIED victory in Africa and again in Sicily—first steppingstone to the invasion of Europe—was prepared and consummated under the protective web of air power, superbly co-ordinated with the attacks of the decisive ground forces and the maintenance of the essential sea lanes.

On one field of battle after another, the story was told: Allied heavy bombers plastering the enemy's rear-area air bases and supply ports; Allied medium bombers blasting his advanced fighter bases, tank columns, and infantry reserves on the roads; Allied dive and glide and fighter bombers slashing and strafing at his forward lines and strong points.

This expert collaboration between air and ground forces is the fruit of a new theory and technique in the use of air power. Developed by both the British and American air forces, this theory recognizes two basic kinds of support that air power can give to ground power. In Africa it found expression in the division of our air strength into *Strategic* and *Tactical* Air Forces. Its success marks it as the pattern for the future employment of the air arm and as one of the most impor-

THIS IS A TYPICAL SETUP FOR AN AIR-SUPPORT CONTROL POST

COMMUNICATIONS lines are laid by a wire tosser mounted on a jeep. Carrying two reels with a mile of wire on each, it can string line at 30 miles an hour. Here the end of the wire is being anchored to a tree at the beginning of a run

RADIOTELEPHONE OPERATOR sends messages by remote control through the transmitter, perhaps several miles away. Set is powered by batteries

TRANSMITTER is camouflaged carefully to prevent destruction by the enemy. Carried by a 1½-ton truck and trailer with gasoline-powered generator, it hands messages by remote control, monitors planes, airfields and headquarters. Its crew of two men serve as drivers, technicians, radio electricians. If it is knocked out, the operational truck can send directly

tant recent developments in the art of war.

Strategic air power, in this technical sense, is represented mainly by large bombers, flying relatively long distances to strike the enemy in his home areas—war industries, communications, ammunition depots, barracks, port facilities. This can be a form of air support, as when Maj. Gen. Jimmy Doolittle's heavy bombers crippled the Axis African air force by bombing out the support fields in Sicily and Southern Italy. But it also may function independently, as in the strategic bombing of Germany by the RAF and the U. S. Eighth Air Force.

Air support in its purest, most direct form, is the job of *tactical* air power. No fixed limit is applied on space, although airmen have a rule of thumb that tactical operations will not usually penetrate farther than 150 miles into the enemy's territory.

The British called this type of air power "close support," although no one has yet been able to give a satisfactory answer to the inevitable question, "How close is close?" Its main work is the bombing and strafing of the enemy at the precise time and place that will assist infantry or armored troops to overcome local resistance.

The old notion that air-ground support was entirely confined to light and dive bombardment has been completely overthrown. Any bomber, up to the giant B-17's and B-24's, may be used on a support mission. As a matter of military economy, however, light or medium bombers usually can perform an air-support assignment with greater speed and efficiency.

Air support can use a fighter plane to

Photographs by
WILLIAM W. MORRIS

CONTROL unit is housed in the operational truck and a tent, both equipped for blackouts. It maintains constant communication with planes headquarters, and airfields. Setup is typical for area where ground forces are making attack

COMMAND of the control unit, below, is a clearing house for information gathered by air and ground reconnaissance, requests from headquarters for attack missions, and reports of attacks made. Such a unit usually serves for a division

TELETYPE affords direct communication with headquarters and airfields, with a permanent record at both ends to reduce chances of errors and misunderstandings. Three men operate the machine carried in the control truck. Telephone and radio can be used to supplement the teletype

strafe the enemy, a glide or low-level bomber to drop delayed-action bombs on his columns, a dive bomber to plunk a load of high explosive on a strong point, a medium bomber to lay a stick or a salvo of ruin across a fortified position, or let down a string of delayed-action parachute bombs in a low-altitude sweep across a troop or truck concentration.

Liaison and reconnaissance planes complete the list of air equipment used, with all types represented from tiny "grasshopper" planes that can land and take off in open fields, to converted twin-engined Lightning fighters that can outpace or outclimb anything the enemy could put in the air.

Men and planes do the fighting, but the lifeblood of their work is communications, and here again every method is put to use, from the simple act of waggling a plane's wings or dropping a message, to the most highly developed radio and wire equipment.

Basic communications from headquarters to air bases are carried out by teletype wherever possible. Teletype is unique in providing both ends with an instantaneous, permanent copy of the order or message, thus cutting the chance of error or misunderstanding down close to zero. The telephone and radio circuits supplement this, and radio naturally is invaluable for communication with planes in flight, when plans must be altered at the last moment.

Wire-tossing jeeps that lay phone and teletype wires at 30 miles an hour help keep the communications system functioning even during periods of rapid movement. Radio communication in the field is carried on

AIR SUPPORT PERFORMS MANY IMPORTANT JOBS

TRANSPORT. Big C-47 transport planes like these carry paratroopers and tow gliders loaded with airborne troops far behind the enemy's lines. They also bring in important personnel and supplies, evacuate wounded

LIAISON. Tiny 'grasshopper' planes carry messages and transport officers behind the lines. Equipped with radiotelephone, they can perform reconnaissance in cases where high speed and armament are not needed for defense

mainly through a series of highly ingenious trailer trucks evolved by the Air Forces. The trailers carry their own generators, but tap into power lines where they are available. If the enemy air force is operating in strength, wire can be laid and the entire trailer operation carried on by remote control, with as much as seven miles between the broadcasting unit (which might be spotted by enemy radio direction finders) and the operational unit which is originating the messages. If the remote-control truck is knocked out by enemy bombing or artillery fire, the operational truck has duplicate sending and receiving equipment to continue work.

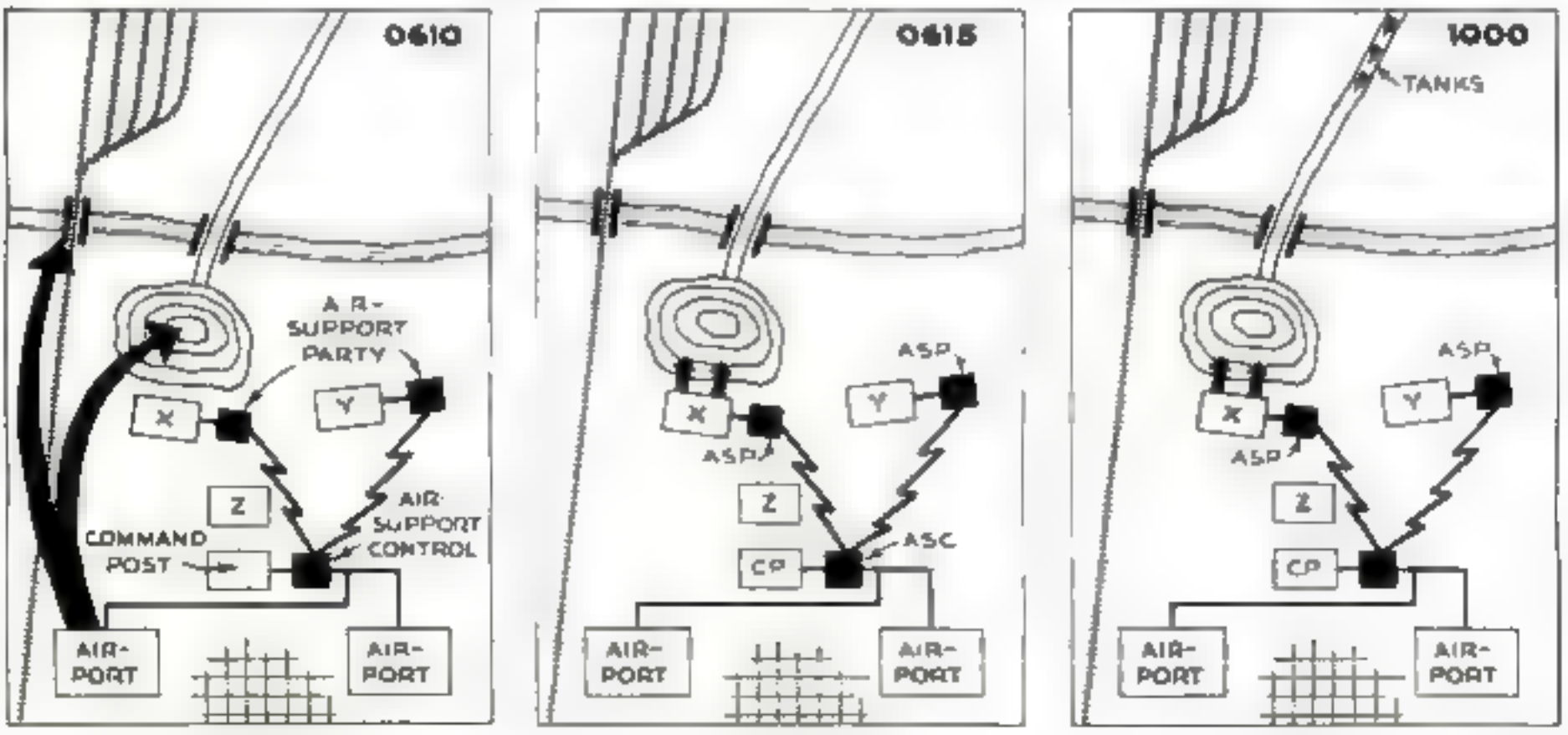
Into these communications centers pours the endless flood of battle information—requests from headquarters for attack missions, reports of attacks carried out, and disposition of enemy units observed by reconnaissance aircraft.

Liaison between air and ground forces is effected by the assignment of air officers to work in co-operation with the ground commanders. An Air Support Command normally is set up to function with an army or corps in the field. An Air Support Control works with a smaller unit, usually a division; a typical Control would include three officers and ten enlisted men with their communications *(Continued on page 208)*

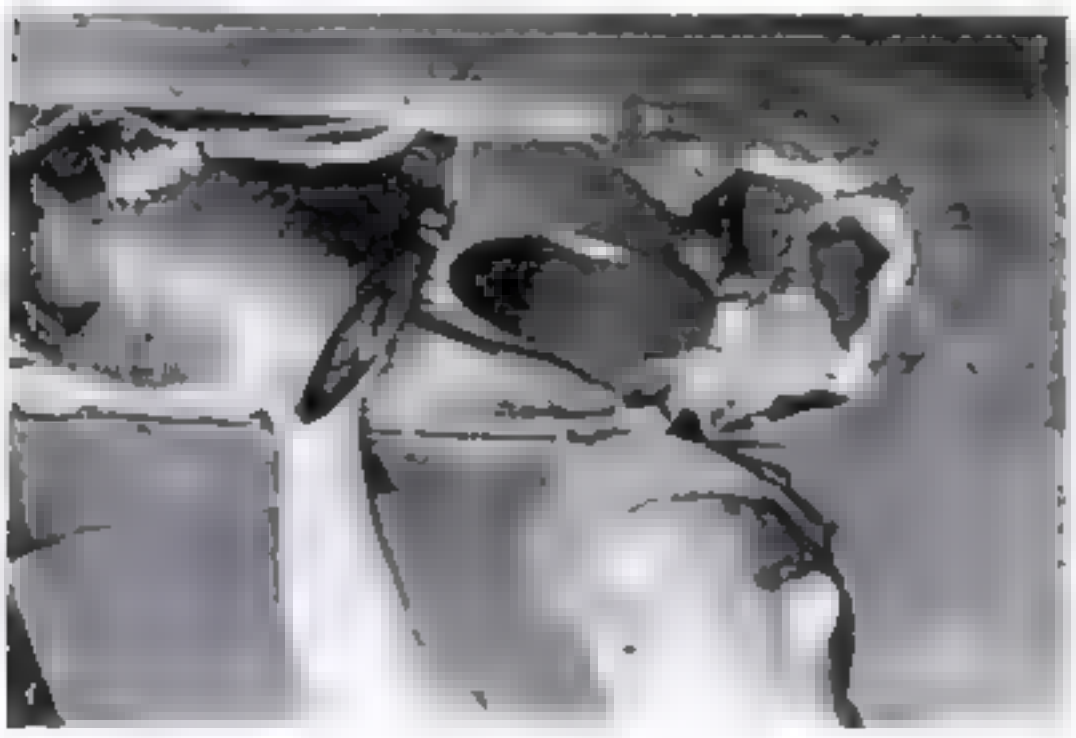
BATTLE SUPPORT. Preparing for an attack by a combat team "X," bombers pound an enemy-held hill and communications lines

Infantry attack is launched. Team "X" meets unexpectedly stiff resistance by mortars, field guns. Artillery support is inadequate

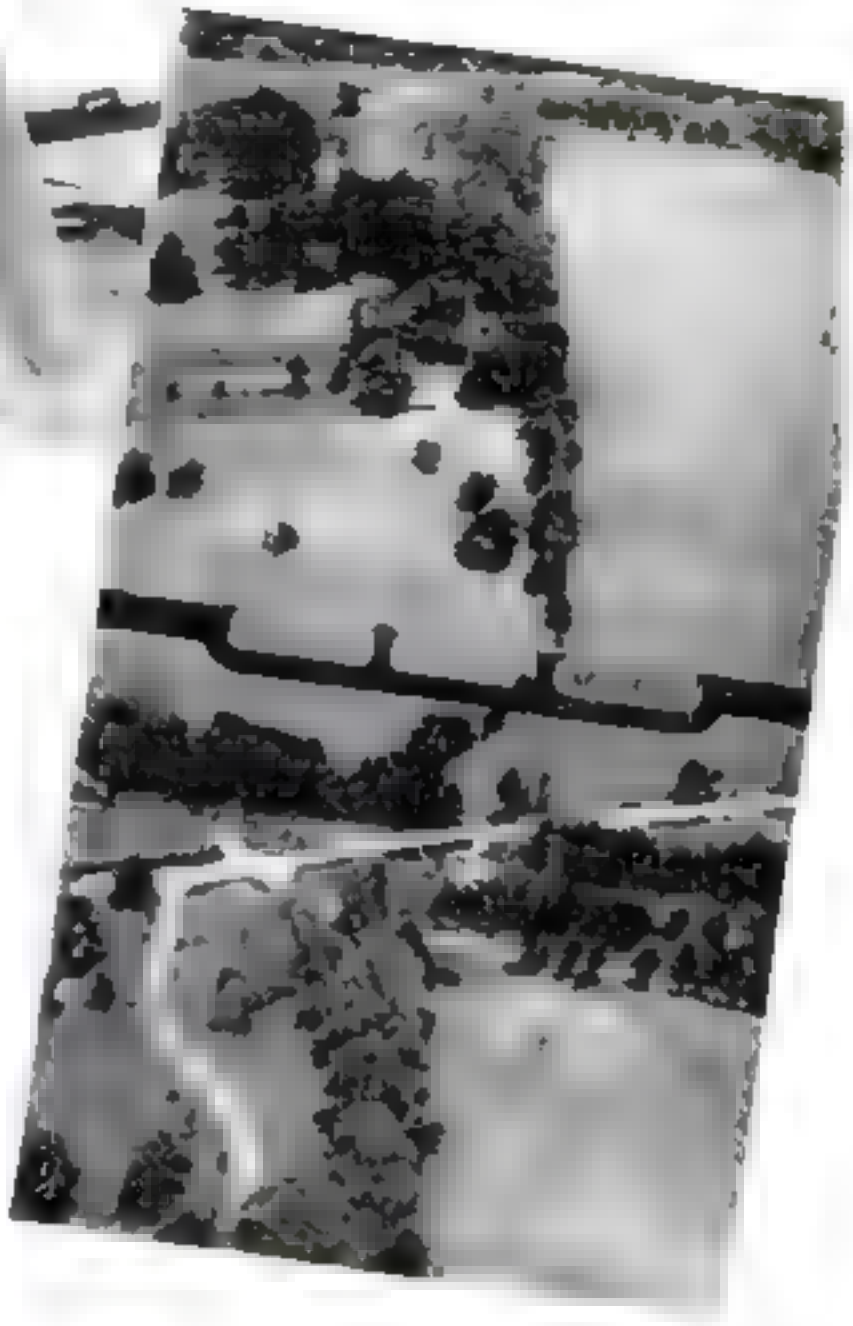
Air reconnaissance reports heavy enemy armored striking force is coming up. Shall air support hit the tanks or help the infantry?



Fast fighters, such as this P-39 Bell Airacobra, serve as camera planes. Below, lenses of two K-17 cameras protrude from its belly, slanted for overlapping composite photos



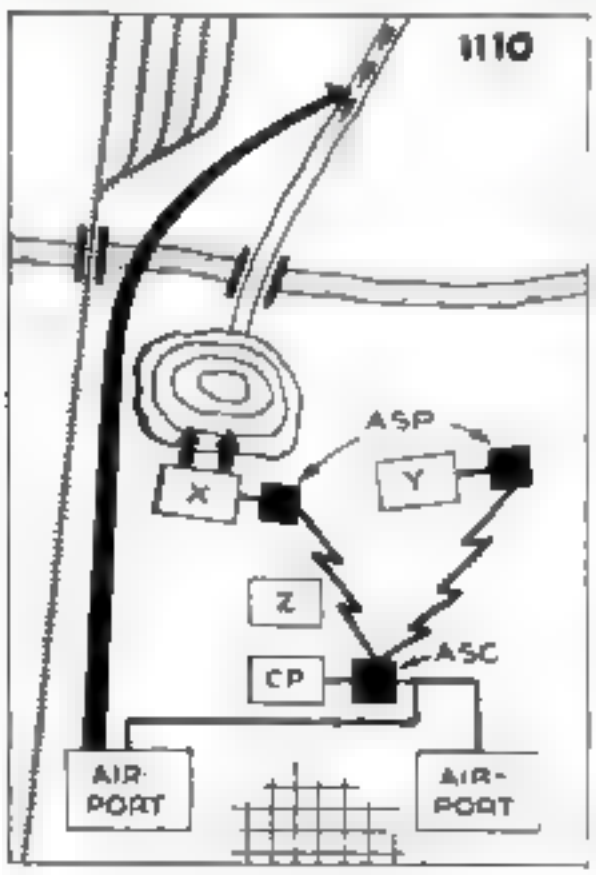
PHOTOGRAPHY plays a big part in air reconnaissance. Pictures developed in the field are sent by wirephoto transmitter to headquarters, where maps are corrected accordingly. The two prints below show a crossroads as shot obliquely from a low-flying reconnaissance plane

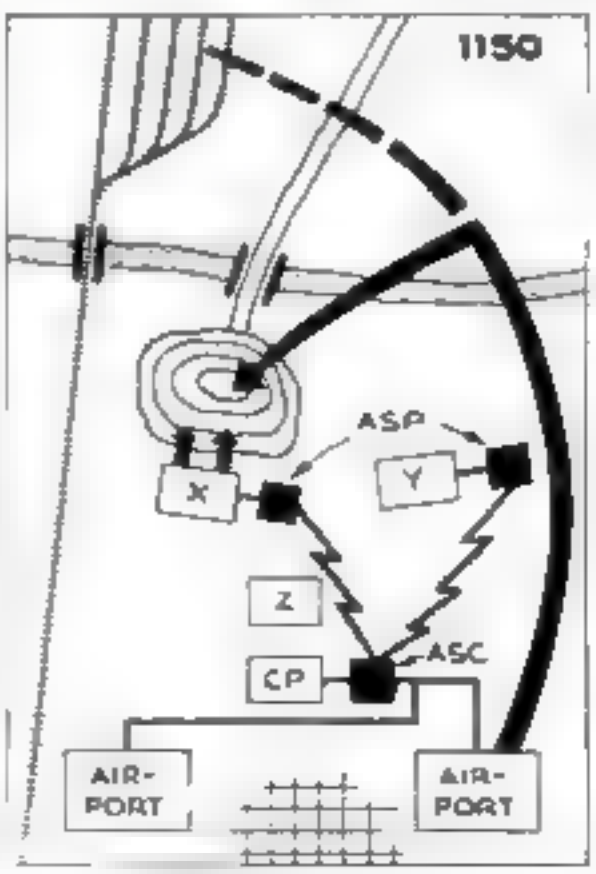


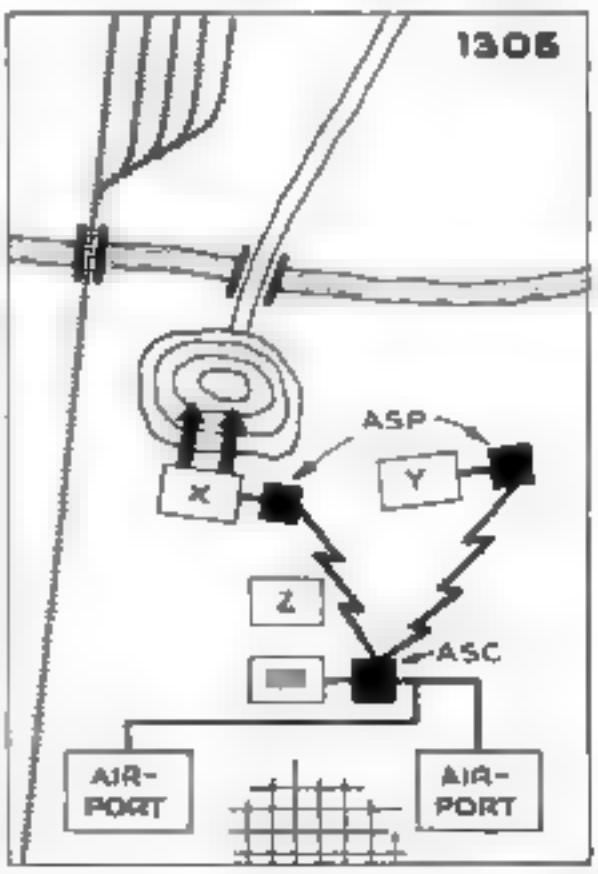
A quick decision is made the tanks must come first A reserve squadron of B-25 s is ordered to smash the enemy armored column

By radio, a squadron of bombers is diverted from a mission to bomb an enemy rail yard and "vectored" to help out the hard-pressed infantry

After bombs have silenced the defending guns, combat team "X" is able to storm the hill and sweep on toward the river crossing beyond







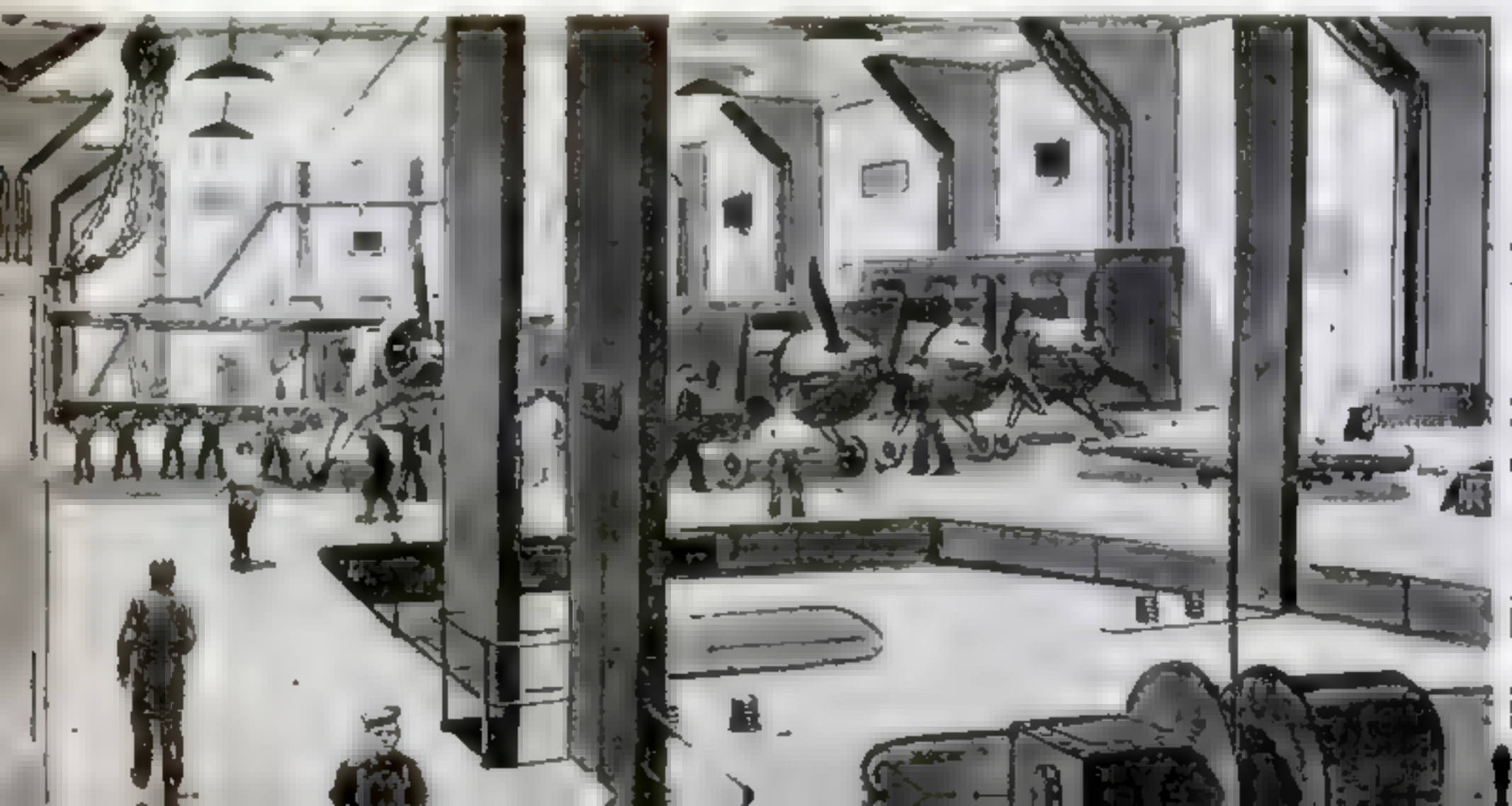
KNOCKING OUT

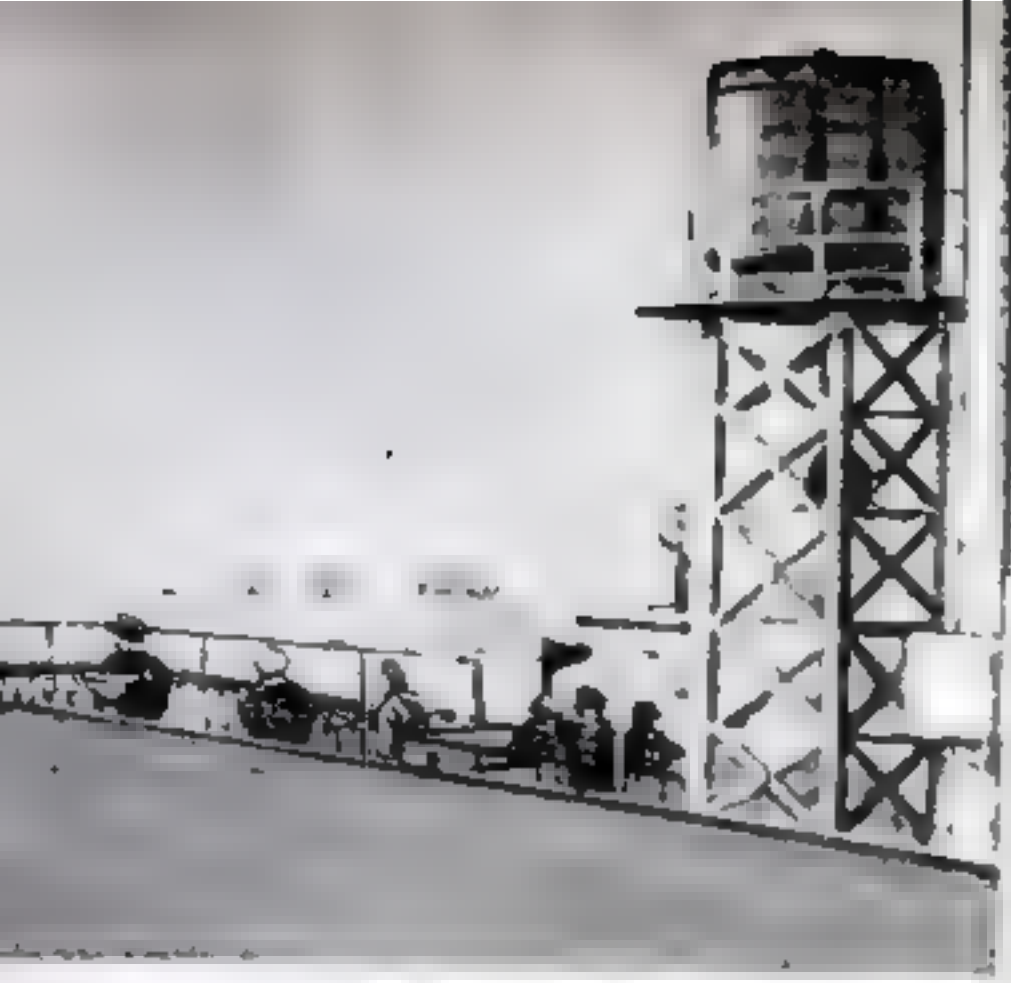
BABY FLAT-TOPS PACK PUNCH

Planes based on tiny carriers spot and kill U-boats before they even see our convoys. One of these flat-tops, converted by U. S. shipyards from cargo vessels and called "Woolworth carriers" by the British, is pictured here by G. M. Davis, artist for the Illustrated London News

...sea-time aboard the converted carriers is welcomed by ...itish as well as U. S. crews. The British like the ...teteria arrangement, calling it typically American. ...e crew's quarters are roomy, for a fighting vessel

This is one of the first views of the hangar of an escort carrier. The elevator mechanism is shown in the right foreground, while the elevator is raised. Wings are being extended on the plane at the left

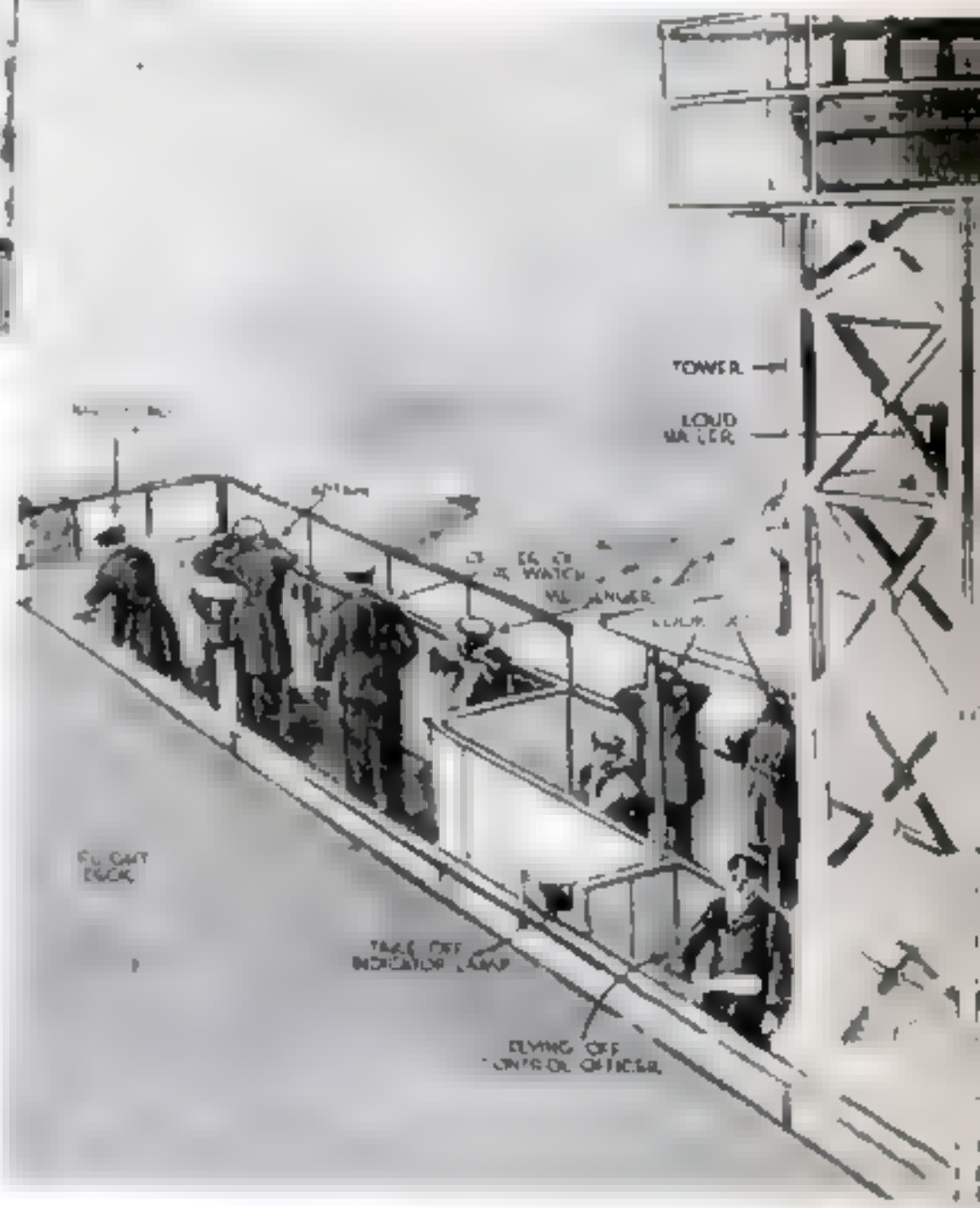




Rising from the deck of a baby flat-top, the plane at left takes part in the daily hunt for wolf-pack submarines. Aircraft from such vest-pocket carriers as this, converted in U. S. yards from 17,000-ton motorships and used by both the British and Americans, are keeping the Atlantic seaway open for valuable war sh pments

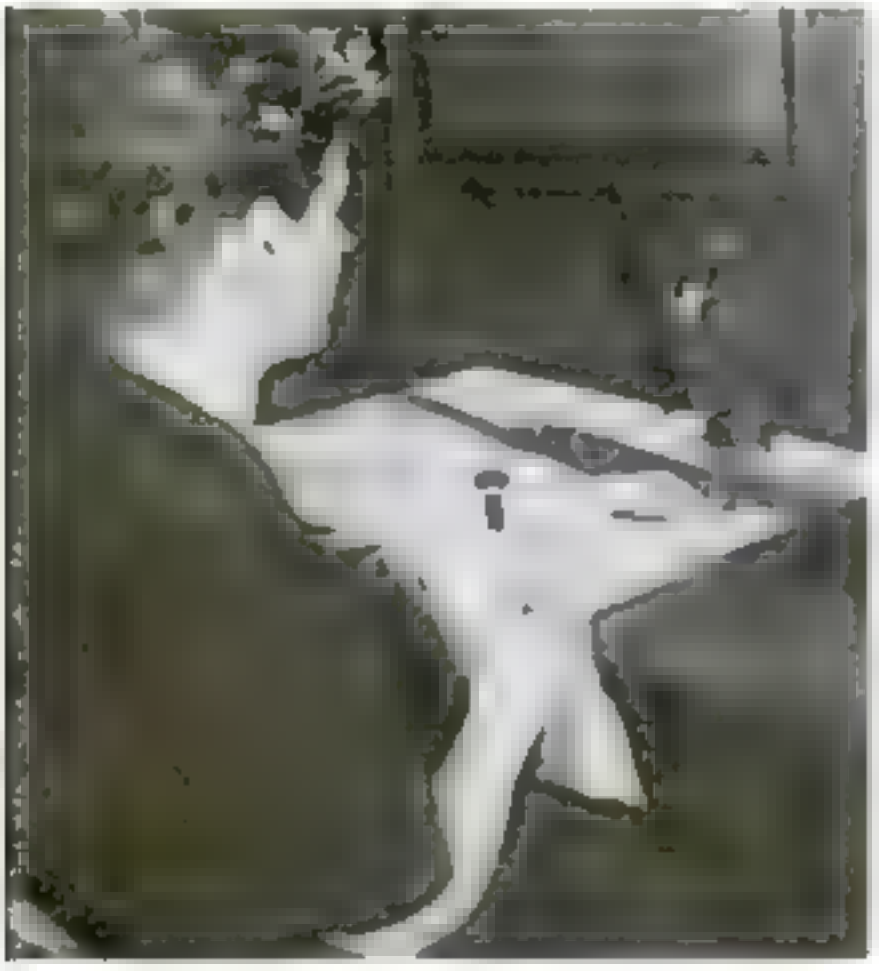
THE U-BOAT

All flying as well as navigation orders come from the bridge, situated outboard on the starboard side. The officer at the extreme right is in control of the take-offs and landings. Sometimes these are very tricky in a badly pitching sea



Funnels, unnecessary in the operation of a motorship, are removed so the flight deck can stretch across the entire top to provide a maximum runway. The location of the plane elevator, shown flush with the deck, and other parts of these baby flat-tops, is given in the drawing below

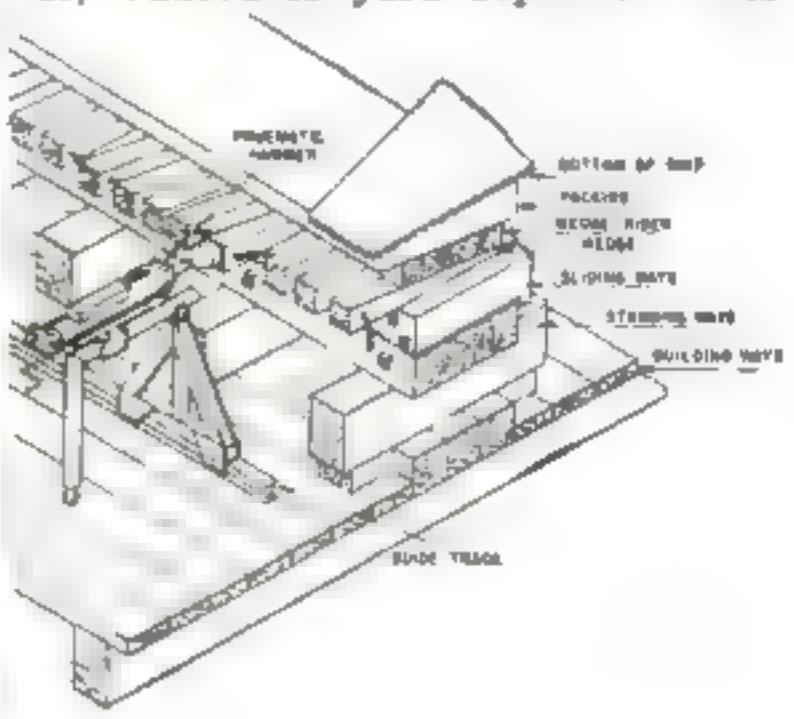
BUNA BOOTS, made to the specifications of regulation rubber boots, are among the latest products of the Government's synthetic-rubber program. Turned out in quantity on the production lines of the Connecticut plant of the United States Rubber Company for essential workers, they are made entirely of buna S and rubber cement.



SEEING FOR THE BLIND, an "electric eye" guards sightless sewing-machine operators by applying a brake when fingers near the needle. Developed by J. O. Kleber and M. G. Gregory, of the American Foundation for the Blind, it also signals a broken thread.

CAN OPENERS with a blade that folds flat are being furnished U. S. soldiers for use on tinned rations. The opener weighs a fifth of an ounce and fits on a key ring

MECHANIZED LAUNCHING has replaced brawn at the Kaiser shipyards and cut man-hours on the job by two thirds. An air ram on rails now hammers in wedges at the rate of 11 a minute to lift the cradle and shift the weight of a completed ship from keel-blocks to sliding ways. Eight rams, each handled by three men, are required to drive the 1,000 wedges used in launching a Liberty ship. The ram is the invention of Fred Schlotfeldt and Kenneth Hunter, Vancouver yard superintendents.



With a watch and two charts you can find your position anywhere in the world.

Aided by the brightly shining stars, these three men on a raft could be in the middle of the Pacific and still have a good chance of reaching the safety of shore. Currents, winds, clouds, reflections, birds and sea life will help if they know how to read their meaning

How to Navigate a Raft

ANCIENT ART OF THE POLYNESIANS IS REDISCOVERED TO AID SEAMEN AND FLYERS ADRIFT FAR FROM LAND

By SEYMOUR FREIDIN

SUPPOSE you got tossed out on the ocean from a torpedoed ship or a plane that couldn't make it home after a bombing raid. Do you think you could find your way to land? You stand a good chance of doing just that if you have with you on your raft a watch in a waterproof case (or, better still, in a transparent, waterproof rubber sack that can be kept closed) and two charts, one of the heavens and one a navigational base chart of the world, and both drawn to the same scale.

Even without these basic implements, Polynesian travelers of some 600 years ago made long voyages over the trackless Pacific —the last of them a great colonization trip from Tahiti to New Zealand, a distance of 2,500 miles. Their navigators used simply their eyes, their sense of hearing and of smell, and a primitive knowledge of the heavens and the sea.

But their method of navigation has been buried these past six centuries in a maze of Polynesian song and legend—known only to their priests and wise men and transmitted by word of mouth from generation to generation since economic necessity and tribal differences no longer prompted these great sea

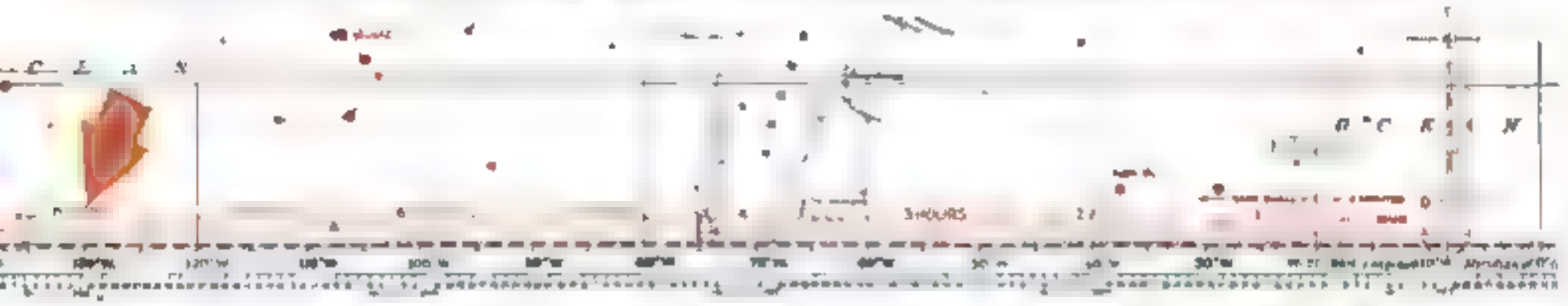
migrations. Their secret has only recently come to light, and it is so remarkably simple that a system based on it opens the prospects of successful navigation to the most absolute landlubber.

Capt. Harold Gatty, who was Wiley Post's navigator on his first round-the-world flight and has passed most of his life in the South Pacific, has written "The Raft Book" (the George Grady Press, New York) based on extensive research in Polynesian legend. "The Raft Book" is intended as a guide for those lost anywhere on the world's oceans. Through the courtesy of Captain Gatty, POPULAR SCIENCE is able to present here some of its more important features.

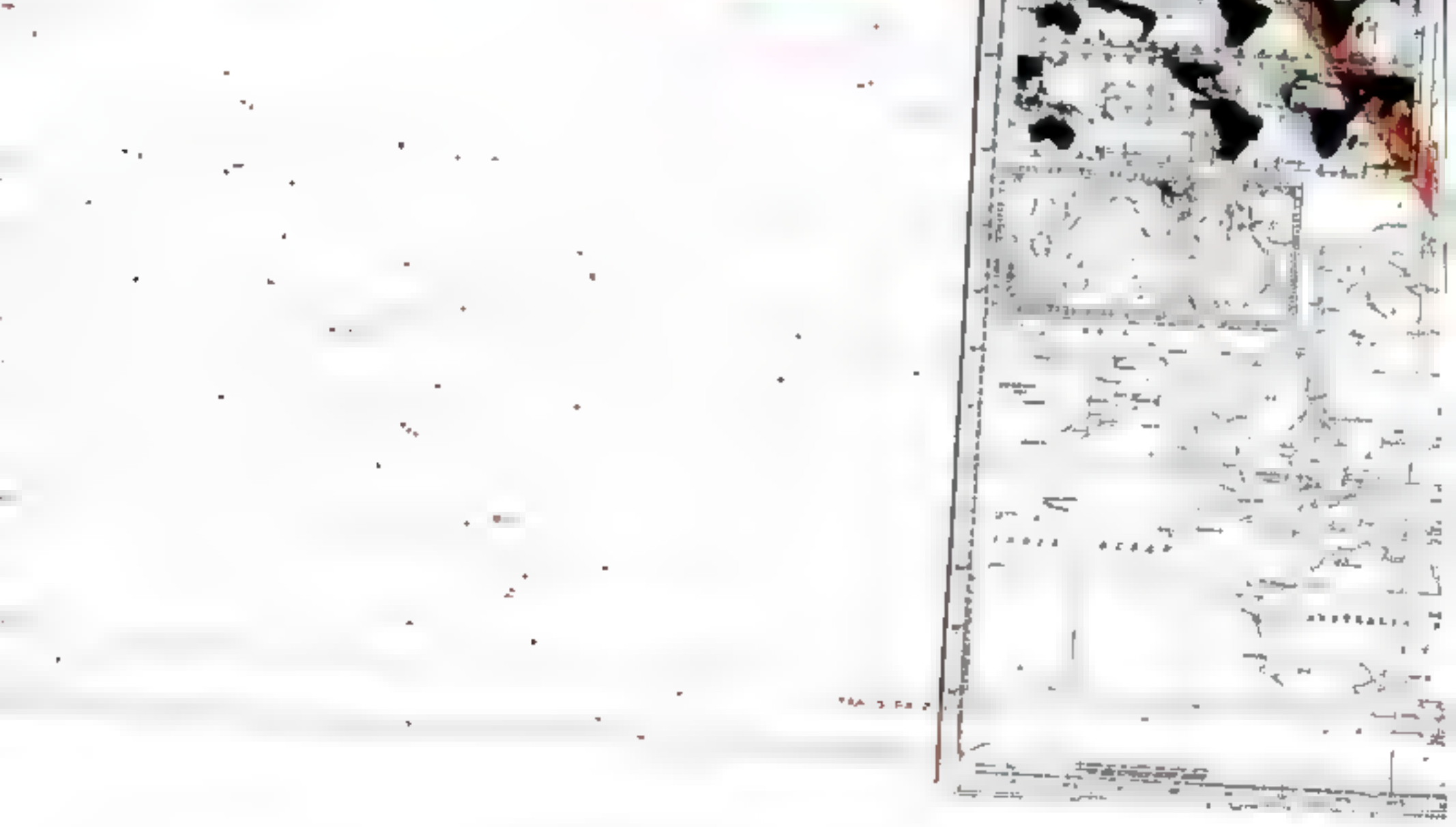
What value there is in following the stars, what various types of sea birds and fish indicate, how currents and winds may be used to advantage, what aid can be had from clouds and reflections in the sky—a knowledge of these things helped the Polynesians reach their destinations, and they will help the average man today as well, even if he is without training in navigation.

With neither charts nor watch, the Polynesians relied on a traditional lore of the stars, viewing them as moving bands of

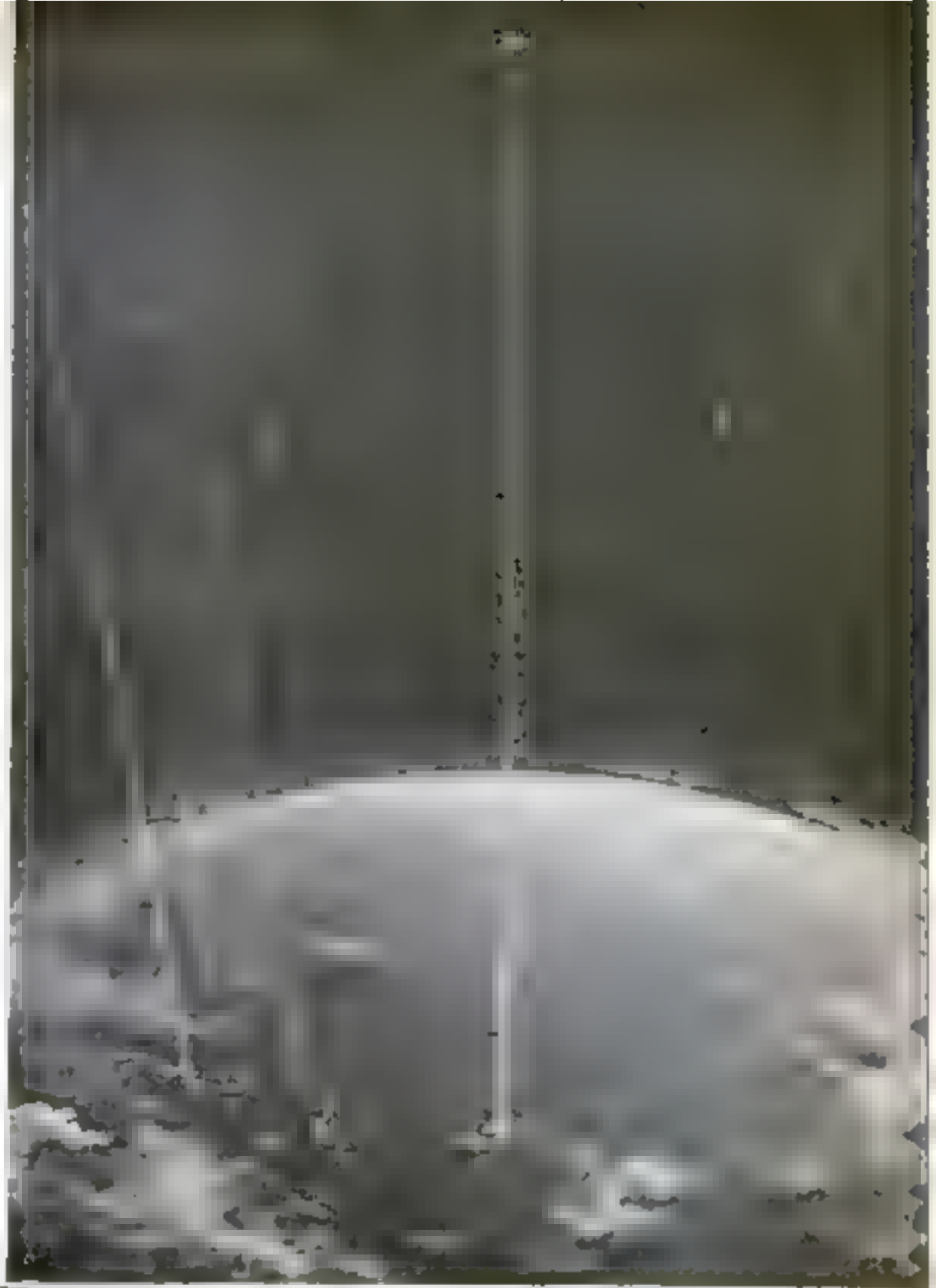
WATCH AND STAR CHART GIVE THE EXACT POSITION OF THE RAFT



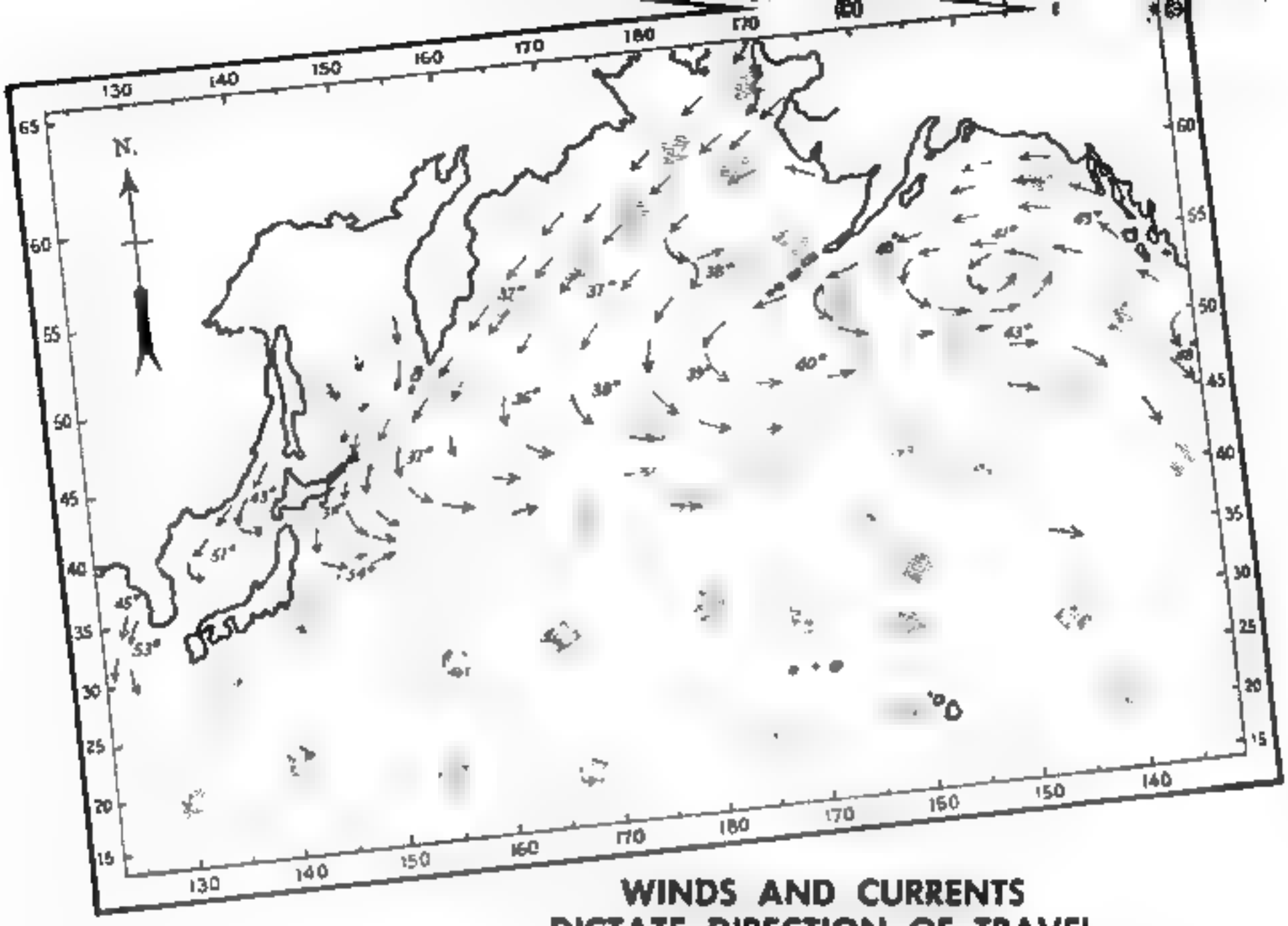
Out on a raft in the Pacific at 8 a.m. Greenwich time October 1, the amateur navigator takes his bearings. He matches the zero hour on his star chart with the date on the navigation base chart and marks off eight hours (at the arrow)



Moving the zero to the new point and identifying the star above him as Markab, he spots his position on the base chart and finds he is east of Hawaii. The star chart is looked at as from above



Stars were looked upon by the Polynesian navigators of six centuries ago as moving bands of light that passed over the same islands night after night. Those passing over particular islands were memorized and used as beacons to lead the Polynesians to their destination. At right and in the diagram above, Sirius is an overhead star for Vanua Levu in the Fiji Islands at three minutes past midnight on January 1 1944. All the stars are shown in their actual position for this moment. On each succeeding night they will appear in the same positions about four minutes earlier



WINDS AND CURRENTS DICTATE DIRECTION OF TRAVEL

= WIND

= WARM CURRENTS

= COLD CURRENTS

Next, the raft navigator turns to a chart of winds and currents in the area of the Hawaiian Islands and finds that if he uses a sail he may be blown far to the south, but that the current will carry him in. He can cast a sea anchor and drift with assurance

light. They knew all the stars of each band that passed over the islands in which they were interested, and knew what star would be over a given point at a given time. Then they simply set their course by this star. This required years of memorizing, however, and restricted the Polynesians to the stars passing over the islands with which their navigators were familiar.

Since stars and their positions in different seasons of the year cannot be memorized overnight, Captain Gatty simplifies this system of navigation by providing a chart of the stars with markings on the border in Greenwich time. If you are able to recognize a star overhead and identify it on the chart, it makes little difference whether you know its name.

One essential feature of Captain Gatty's star chart is that it is printed on transparent paper. Thus, with the stars visible from either side, the chart may be used both to check on the night sky and to find the position of given stars on the navigational base chart of the world. In checking on the stars overhead, the chart is looked at from one side; in locating them on the navigational chart, it is looked at from the other, as if you were yourself above the stars looking down on the ocean.

To complete the system of navigating by the stars, you must keep your watch running on Greenwich time or be able to make calculations from it in Greenwich time. This is necessary, since the transparent sheet is moved over the navigational chart in accordance with the time of day in Greenwich time and with the date.

Just as the Polynesians "chased the stars" to their destination, you can pick out a star on your course and follow it with equal assurance of success. The movement of your "guiding star" must be watched hourly, and your course set an increasing or decreasing amount to one side according to whether the star is moving away from your destination or toward it.

In weather when the stars are not discernible, there is a duration-of-the-day method of setting your course that will serve as well. This consists simply of measuring the length of time between sunrise and sunset, and using this knowledge along with the date to find latitude and longitude in hemisphere tables included on the navigational chart. Probably the only way to determine the duration of the day on a raft is the slow but sure one of taking readings from your watch at both sunrise and sunset.

Eyes and senses must also be brought to

bear to pick up and recognize signs that will help you guide your raft toward land. Use the winds and currents in propelling your craft, sailing if the wind is right, or using a sea anchor that will keep you drifting with the current. Before deciding which to try, however, decide whether the resultant winds—the sum total of the prevailing and the other winds—or the current will better serve you. You should know, too, that the winds may blow in one direction and the current may flow in one directly opposite. Captain Gatty has prepared winter and summer charts of the winds and both warm and cold currents covering all waters.

Birds can also be a big help in finding direction. The Polynesians saw land birds take off year after year in the same direction and knew that they could not rest on the ocean. In the great voyage to New Zealand, they followed the route of the long-tailed cuckoos after repeatedly observing the migration of these birds from Tahiti

The Polynesians frequently carried frigate birds as an aid in sighting shore. Released, these birds would fly upward, spot land if any were to be seen, and go directly to it, or else, if land were not in sight, they would return to the boat, from which they could be set loose again later on. Pigeons could be used easily as substitutes.

Captain Gatty has prepared pictures of the main sea birds along with a list of their characteristic markings to help in identifying them. Noting their flight is one of the most important ways of telling when you are near land and in what direction it lies. The type found over any area of the ocean depends on the temperature, depth, and salinity, and the movement and kind of marine life present. Identifying the birds will often give additional information.

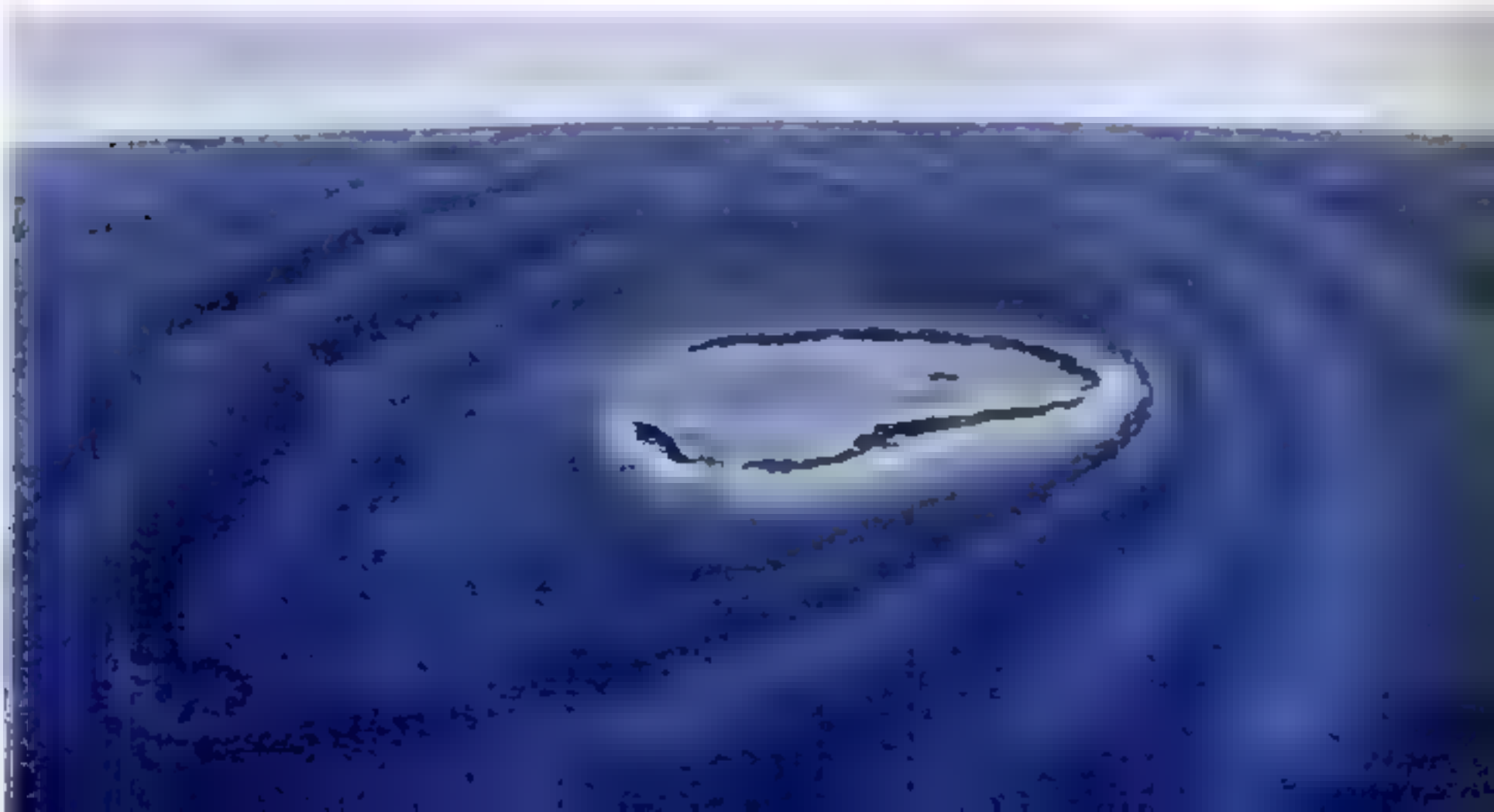
Most tropical sea birds do not range far from their breeding grounds on islands and coasts, and as a consequence they are not often seen far from land. All of them are edible, and they are easy to catch. You can bag an albatross or other hook-billed bird

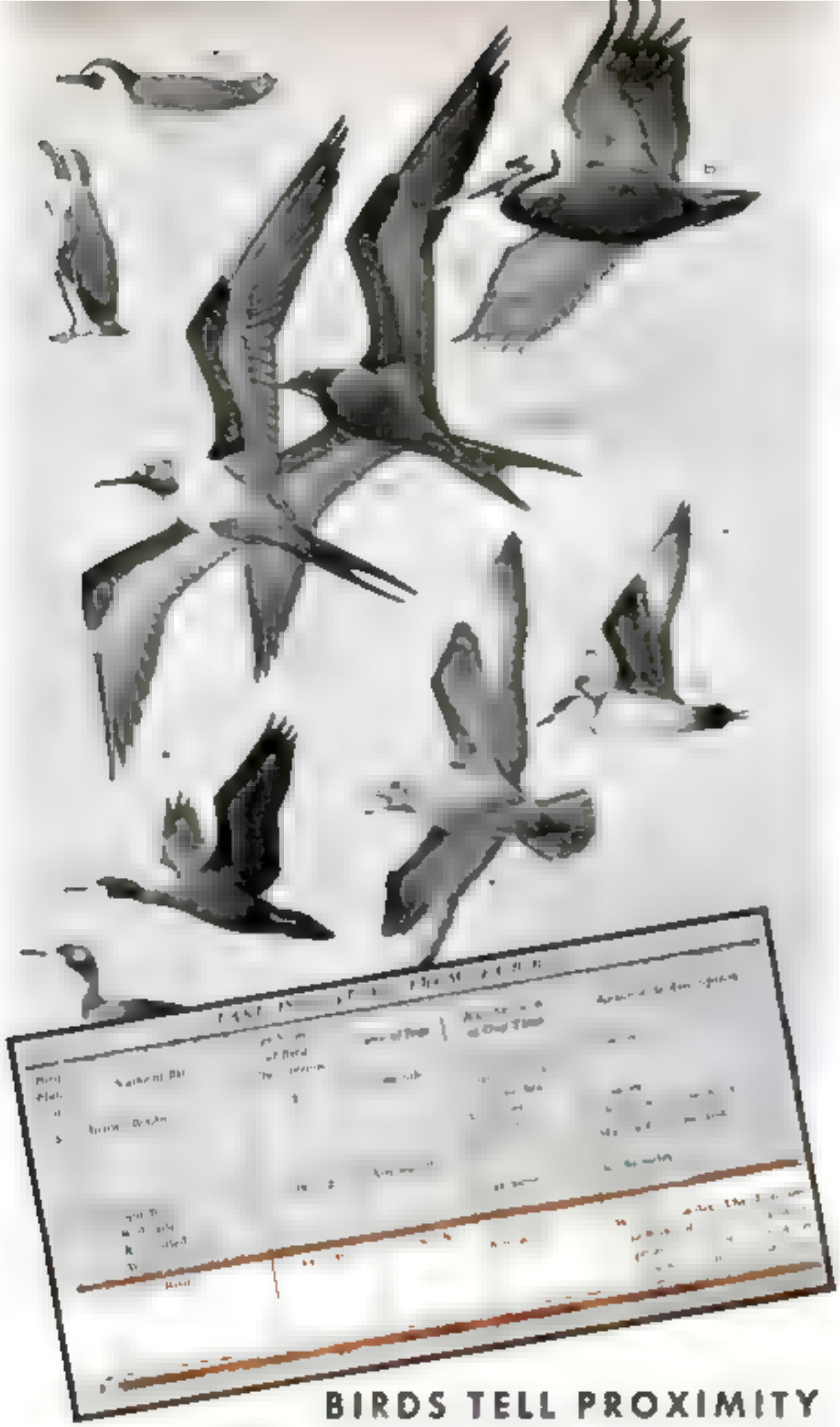
SMALL CLOUDS AND SWELLS DISCLOSE THE NEARNESS OF LAND

Note: In Captain Gatty's "The Raft Book," these illustrations appear in full color

↑ Because white sand reflects more heat than the sea, small clouds hover over all atolls

Parallel swells, curving to the shape of the land, are driven toward an island by the prevailing wind ↓





BIRDS TELL PROXIMITY AND DIRECTION OF LAND

Close watching of sea birds is a good guide to shore. These creatures cannot land on the ocean, and toward dusk they always fly back to the nesting grounds. Above are excerpts from Captain Gatty's book, giving pictures of sea birds and outlining their most helpful characteristics

with a shiny metal object tied to a string.

Keep a sharp lookout for fish and other surface life, bearing in mind that rich marine life occurs in quantity only relatively close to shore. Far out, there generally are whales, porpoises, large sunfish, and ocean bonitos.

Polynesian navigators watched the sky, knowing that small clouds hovered over atolls. This is because the white sands reflect more heat than the surface of the water and cause a difference of temperature above. The cloud over your atoll will be a little to the lee side, blown that way by the prevailing wind. You will be able to see on its underside a reflection of the bright turquoise lagoon long before the atoll appears over the horizon.

Deep water is a poor reflector, but lagoons and other shallow waters play their colors on a cloudless sky. In polar regions, this results in "water skies" and "ice blinks." The former, a sharply defined shadow in a bright sky, indicates open water in the midst of ice, and the latter, a patch of brightness in the gray, means floes or shore ice in open water.

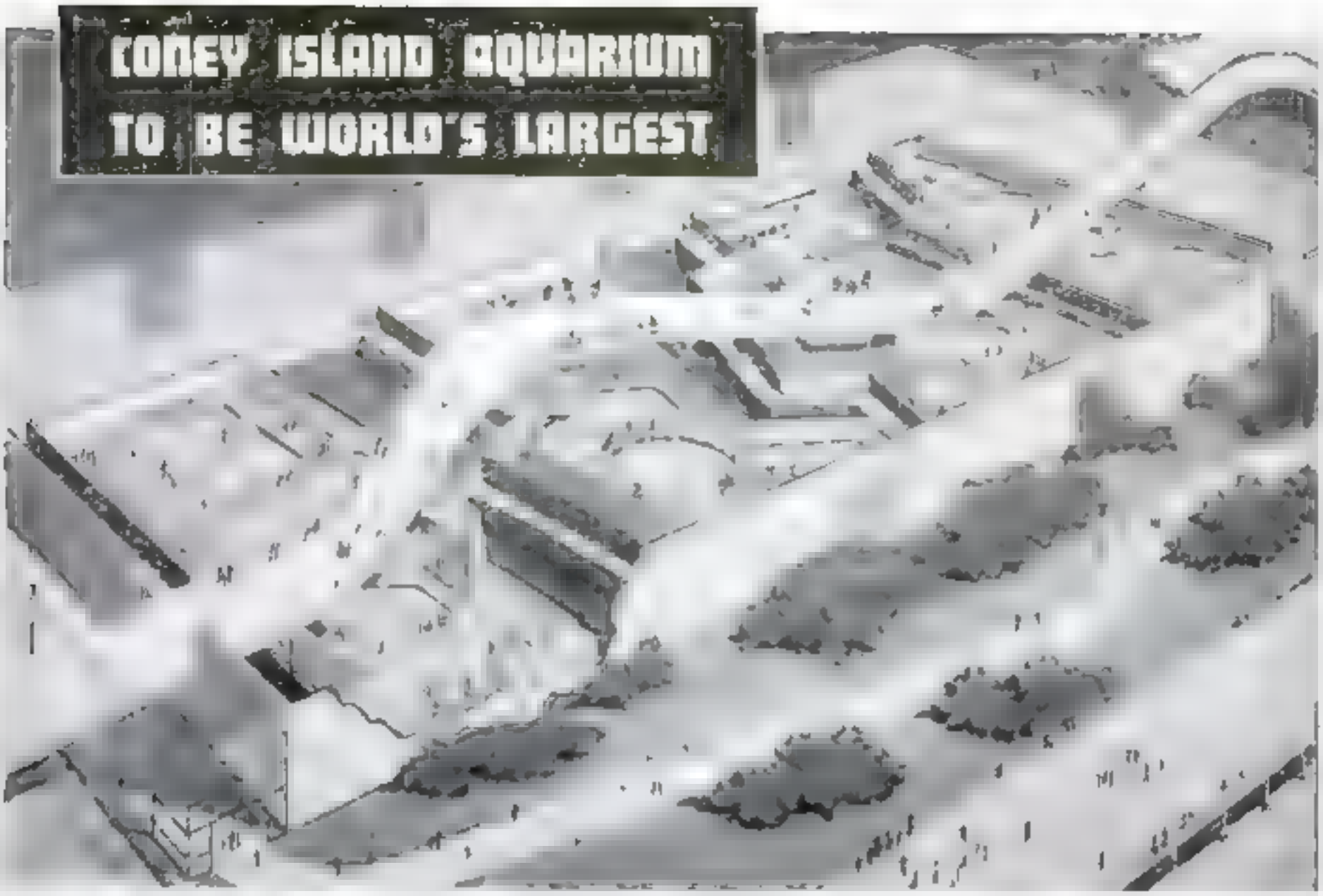
Waves and swells tell their tale as well. The prevailing wind carries parallel swells toward an island, and they curve to the shape of the land as they near it. Those directly in front form waves that break on the reefs.

Sounds also can give you a good idea of how near shore may be. Gulls, with the exception of the kittiwake, are not found far out, and their cries in flight generally indicate near-by land. In fact, continued cries of sea birds from one direction usually signify a roosting place on the shore. There are such sounds, too, as breaking waves, fog whistles, and buoys. And, of course, if you hear a factory or train whistle, it's all over but the celebration.

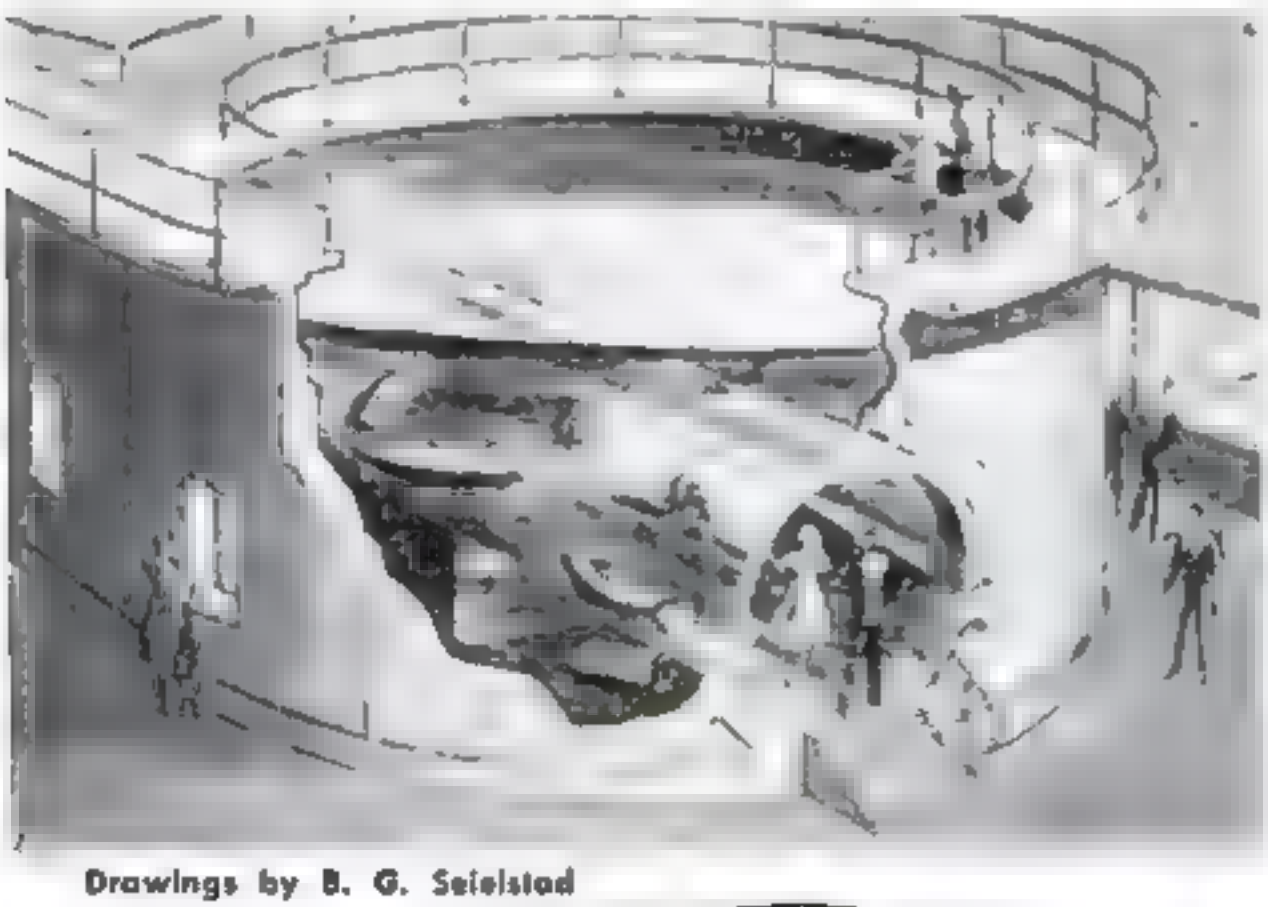
But don't try to go head on into the shore when you actually sight it. It's usually dangerous to attempt a landing from the windward side of an island, and even on the lee side, heavy surf may make it hazardous. Don't risk everything by trying to fight your way in. If you have any doubts, remain outside the breakers and signal for help with any means at your disposal—a pistol shot, a flare, a distress flag, or a plain, lusty shout.

Navigating the high seas in a small boat is perfectly possible if you know how. The Polynesians did it—and so can you.

CONEY ISLAND AQUARIUM TO BE WORLD'S LARGEST



THE largest aquarium in the world, to be built by New York City at an estimated cost of $1 500,000, has been tentatively planned for postwar construction at Coney Island. In addition to virtually every known type of fresh and salt-water fish, the aquarium will exhibit biological specimens and aquatic birds gathered from all parts of the world.



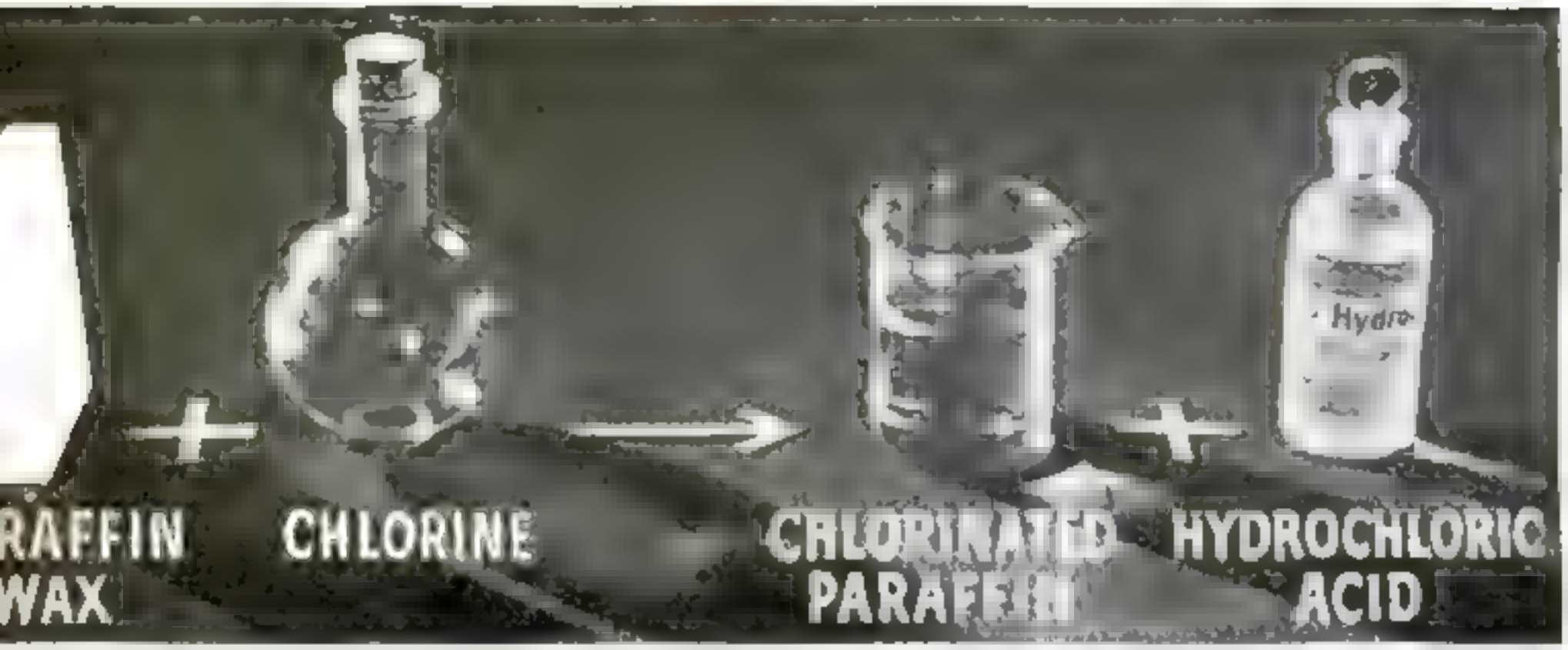
Drawings by B. G. Seielstad

Covering a 10-acre area, the proposed aquarium will include a main building housing practically every fresh and salt-water fish known to man, outdoor pools for seals and penguins, and a special aquarium for children. There will also be restaurants, a lecture hall, and a promenade deck. The above is our artist's conception of how the 'oceanarium' will look

Among the interesting novelties proposed for the aquarium are glass-enclosed passageways through the giant tanks which will enable visitors to get unusual views of the fish. There will also be a catwalk at the top of each tank, and viewing windows in its sides

Plans call for a special section in which waterfowl and aquatic birds will be housed

PARAFFIN PRODUCT FIREPROOFS, WATERPROOFS FABRICS



BY BUBBLING chlorine gas through melted paraffin wax so that the chlorine replaces the hydrogen in molecules of the paraffin, industrial chemists are now economically producing a noninflammable wax which, when applied to textiles, renders them waterproof, fire-resistant, and mildewproof. The hydrogen that is eliminated from the wax is then made to combine with excess chlorine and thus produce hydrochloric acid as a by-product. The odorless, durable wax can also be used in making plastics.

Shown above is the chemical sequence in which chlorine gas, bubbled through paraffin wax, produces chlorinated paraffin. The hydrogen that is eliminated from the paraffin is then combined with excess chlorine to produce hydrochloric acid

In a test of the wax's waterproofing qualities, as shown at far left, a treated piece of fabric resists water poured over its surface, while an untreated piece of the same fabric allows the water to pass through it into the receptacle

At the immediate left, ordinary paraffin is shown burning steadily after having been ignited, while the chlorine-treated paraffin remains unaffected when it is placed over a match

The third protection that the new wax affords textiles is to render them mildewproof. These pictures show the difference in the reaction of two pieces of the same material—one treated, the other untreated—after prolonged exposure to dampness

POPULAR SCIENCE

When Russia Fights Japan

A distinguished war correspondent forecasts a colossal conflict in the Far East—with the Japs the losers.

Tough, well-trained troops like these will meet the Japs in the Battle of Siberia. Antitank gunners, clad in white for camouflage against snow, drag their ski-shod piece into position for point-blank fire. The Red Army's antitank tactics stopped the Nazi panzers—and will stop the Japs

By WALTER KERR*

DISTANT Siberia may become one of the great battlefields of this war.

For years now, a defiant Russian army has glared southward across the Amur River into Manchukuo, where the treacherous Japanese maintain their powerful Kwantung Army.

Two strong forces poised to strike. Two traditional enemies. Mutual distrust. Mutual hatred. A conflict of interests that goes back more than 50 years.

When that war comes—and the people of Moscow told me it was inevitable—the world will find out that the Russians never took their eyes off the Japanese, even during the most critical days of the battles for Moscow and Stalingrad. They never weakened their Far Eastern force. On the contrary, they strengthened it, and they will continue to strengthen it as they continue to wage successful warfare against the Germans in the West.

The Battle of Siberia will be no side show, but a war with a million men and more on a side.

In the last two years, the situation in the Far East has changed considerably. In the beginning the Russians had their hands full with the Germans, and the only question was: Will the Japanese attack? Now the Russians are fighting a winning war with Germany, and the question is: Who will attack first, the Russians or the Japanese?

When I first got to Russia, Germany's mechanized army was driving on Moscow, and the people asked me: "Do you think the Japanese will stab us in the back?" But this year, following the successful Russian counteroffensive against the Germans west of Stalingrad, an official of the Russian Foreign Office told me: "You have been here long enough to know that when Hitler is beaten we will take on the Japanese."

The only question then is which country

---

* *Reported crucial events of the war from Vienna, Prague, Berlin, Paris, London, and Moscow. Long service in Russia makes him an authority on conditions in that country.*

Interstate enemies across the world in Manchukuo. Traversing the iron and coal fields of the Kuznetsk Basin and the rye and wheat fields of the Irkutsk area, the double-track line would be a prime objective of a Japanese attack. Hedging against the loss of this vital rail link, the U.S.S.R. has built a second railway paralleling the Trans-Sib far to the north. This new line could be more easily defended and kept in service

will attack first. The answer provides the clue to the nature of the campaign that will be fought.

If Japan attacks, in a suicidal move of despair, we can expect the Russians to withdraw into the Siberian wasteland until they are strong enough to counterattack. But if Japan waits until Russia attacks, we shall see Russian troops driving deep into the heart of Manchukuo. For Russia will attack only when Russia is ready.

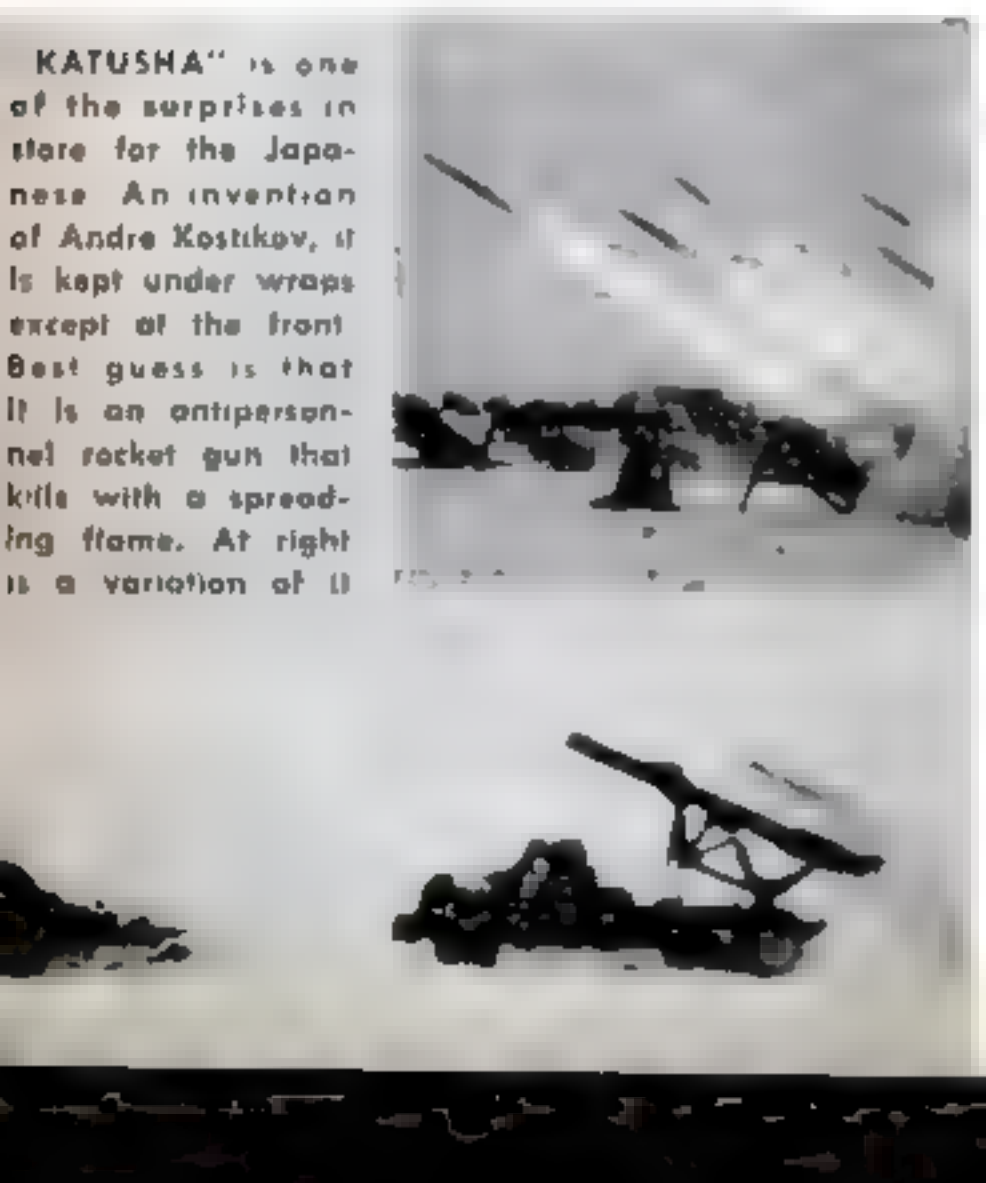
Russia this summer was already on a war footing in the Far East. Its divisions were not organized into military "regions," the customary peacetime designations that correspond to our "corps areas." "Regions" had been replaced by "fronts." We began to hear of the "Far Eastern Front" and the "Trans-Baikal Front." In Russia the "front" is a wartime organization headed by a front commander who directs the operations of several armies. In each of his armies he has a separate air force, one or more tank corps, and anywhere from five to 15 divisions.

Out in Siberia the "Far Eastern Front" embraced the eastern part of the Russian line, including the great port of Vladivostok. But Vladivostok is difficult to defend, so front headquarters was established farther to the north in the city of Khabarovsk. Here the commander was Army General Josef Apanasenko, a little Cossack called "Hercules" by his friends.

The "Trans-Baikal Front" was farther to the west—based, as its name implies, just east of Lake Baikal in the city of Chita. Its commander was Colonel General Georgi Kovalev, a big fellow with many years of service in Siberia.

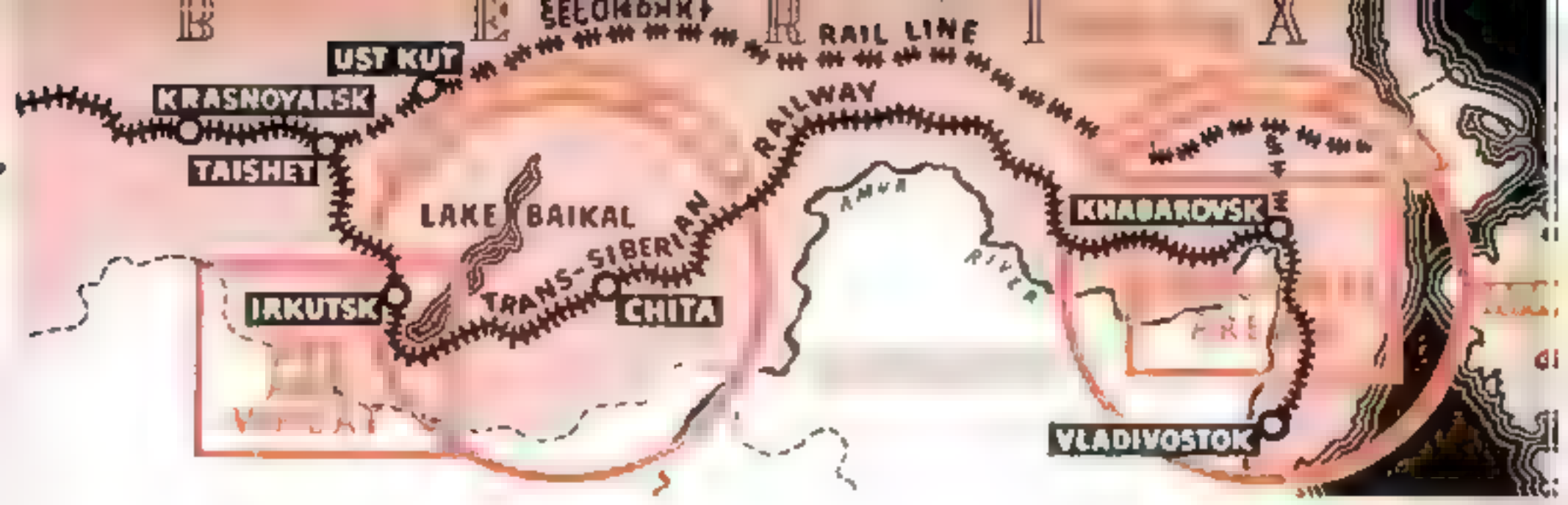
If Japan attacked before Russia was ready in the Far East, Apanasenko would have to fight to defend the Trans-Siberian Railway, Vladivostok, and the new industrial areas that Russia built some years ago to supply its Far Eastern force. Kovalev would have to help Apanasenko by hammering at the Japanese flank, but his great mission would be to take a position astride the railway and prevent the Japanese from pushing along it to the west, toward the rye and wheat fields around Irkutsk and the coal and iron area of the Kuznetsk Basin beyond Krasnoyarsk.

The Japanese might be able to seize Vladivostok in a quick lunge from Manchukuo, and they probably could cut the Trans-Siberian Railway in a number of places. But the gains would be costly and would



"KATUSHA" is one of the surprises in store for the Japanese. An invention of Andre Kostikov, it is kept under wraps except at the front. Best guess is that it is an antipersonnel rocket gun that kills with a spreading flame. At right is a variation of it

CAVALRY will have its innings on the Siberian plains. The Red Army uses mounted troops effectively in masses of two or more divisions. Horsemen of friendly Outer Mongolia will help give superiority



lead to nothing. For the Russians have already moved their Pacific fleet from the waters around Vladivostok, and they have built a new railroad paralleling the Trans-Sib many miles to the north. This line, which can be presumed to be in operation, runs from Ust Kut, just northwest of Lake Baikal, across the tundra regions to Komsomolsk, north to Khabarovsk

Let's go back and see why the Russians have made these preparations for war, why every soldier and civilian I met in 16 months in Russia hated the Japanese the way Americans have hated them since Pearl Harbor, why they feel that war between the two countries is inevitable and that the only question is which country will attack first

We can begin with February 9, 1904, when the Japs, striking as suddenly and as treacherously as they did at Pearl Harbor, attacked the Russian naval base at Port Arthur, precipitating the Russo-Japanese War which ended in disaster for Russia. The people of Moscow have never forgotten that cold February day, nor have they forgiven By the terms of the Treaty of Portsmouth the Japanese not only took Port Arthur but obtained a free hand in Korea and took possession of the southern half of the Russian island of Sakhalin, lying north of Japan.

Then, after the Russian revolution of 1917, the Japanese joined the Americans and the British in a temporary occupation of parts of eastern Siberia. We pulled out in 1920, but the Japanese stayed on until 1922, and then they refused to surrender the northern half of Sakhalin. Finally in 1925 the Russians forced them to withdraw. Diplomatic relations were opened between the two countries

Nothing much happened then until 1931, when the struggle for supremacy in the Far East came out into the open. The Japanese occupied Manchuria, which they renamed Manchukuo. Russia fought back by aiding the Chinese. Japan forced Russia to sell its interest in the Chinese Eastern Railway that crosses Manchukuo, the short cut to Vladivostok

Then the aggressive Japanese cast covetous eyes on Outer Mongolia, but the Russians said "No." That country, they declared, was Russia's sphere of influence. Stalin said he would go to war to prevent Japanese penetration. Border incidents developed. The Japs began testing Russian strength In 1938 they tried to take a piece of territory near Lake Khassan on the border south

Russia's first line of defense against the Japs in Manchuria is a gunboat flotilla on the Amur River Bottom: Soviet infantrymen armed with Degtyarev 7.62-mm. submachine guns ride a 26-ton medium tank

The Red air force has proved its mettle against the Luftwaffe. These are YAK-1 light fighter planes, good on rough advanced airfields. Mongolian types, below, are common among Soviet Far Eastern troops

of Vladivostok. The Red Army kicked them back in a battle that involved the use of tanks and planes as well as infantry and artillery. The Japs tried again the following year to move into Outer Mongolia. In one great battle that lasted only a week, the Red Army surrounded and annihilated the Japanese Sixth Army. Marshal Georgi Zhukov, who won the battles for Moscow and Stalingrad, commanded the victorious Russian force. After that the Japanese pulled in their horns. But by that time every Russian knew that only war could settle the conflict of interests between the two countries.

Now for the weapons the Russians would use in a war with Japan—weapons tried and found excellent in the war against Germany. The Japs would find the Russians among the best artillerymen in the world. Russian divisions are liberally equipped with 45-millimeter (1.8-inch), 76.2-millimeter (three-inch) and 122-millimeter guns. They use them boldly, up forward with the infantry. A great number of artillery regiments are reserved for use by the high command, enabling it to organize mass fire on the sectors it selects for attack.

Russian tanks manned by experienced crews will include the heavy 42-ton KV model and the medium 26-ton T-34, both armed with three-inch guns.

Siberia is good country for cavalry warfare, and the Russians, aided by the Outer Mongolians, with whom they have a pact of mutual assistance—should have clear superiority in this branch. The Moscow conception of the best way to use cavalry is to employ it in mass, in units of two, three, or more divisions.

No American knows much about the Russian air force, but it has been able to keep pace with the German Luftwaffe, so its fighter planes, such as the MIG-3, the YAK, and the LAGG, should be able to handle anything the Japanese can send up.

As for the Red Army infantry, it probably has few equals in the world. Its men are tough, trained to endure hardships, accustomed to the climate, disciplined, and good marksmen. The experience of the war against Germany shows they are not afraid to die. Rifle divisions are thoroughly trained for antitank warfare, and the Japanese are sure to find their armored columns cannot succeed where Germany's armored divisions could not. Every unit has its antitank detachment, and the troops are trained to use antitank rifles, fuel bottles ("Molotov cocktails"), and heavy antitank grenades.

Furthermore, the Red Army has a few cards up its sleeve which the Japanese know nothing about. One is a weapon that the soldiers call "Katusha," probably some sort of a rocket gun that kills with a spreading flame. Russians say it won the battle for Moscow.

Back of the fighting forces is a new industry in the Far East, which has been developed since the revolution of 1917. North of Khabarovsk and Komsomolsk are coal, iron, and oil fields. Most of the oil comes from Sakhalin and is refined in Khabarovsk and farther to the north at Nikolaevsk. There are great cement plants at Vladivostok and Komsomolsk, and three steel plants producing everything from pig iron to rolled-steel products at Petrovsk-Zabaikalsk near Chita, at Komsomolsk (a new shipbuilding and metallurgical center), and at Irkutsk.

The armies of the "Far Eastern Front" and the "Trans-Baikal Front," equipped with excellent weapons and backed by a recently developed industry and an improved transportation system, will employ tactics developed during the war with Germany. There is nothing much about them that was not known to military science before the war, but through trial and error, defeat and victory, the Russians have found out the best ways to use their available manpower and equipment. They have learned to fight on a wide front, employing mobile striking forces to smash enemy attacks and to obtain superiority in the sectors selected for offensive action. In the early days of their war with Germany, they were a little inclined to slug it out with the enemy, regardless of the enemy's strength. Now they have learned to fall back rapidly and then to strike in counteroffensive at the proper moment. They have also learned a great deal about communications and supply.

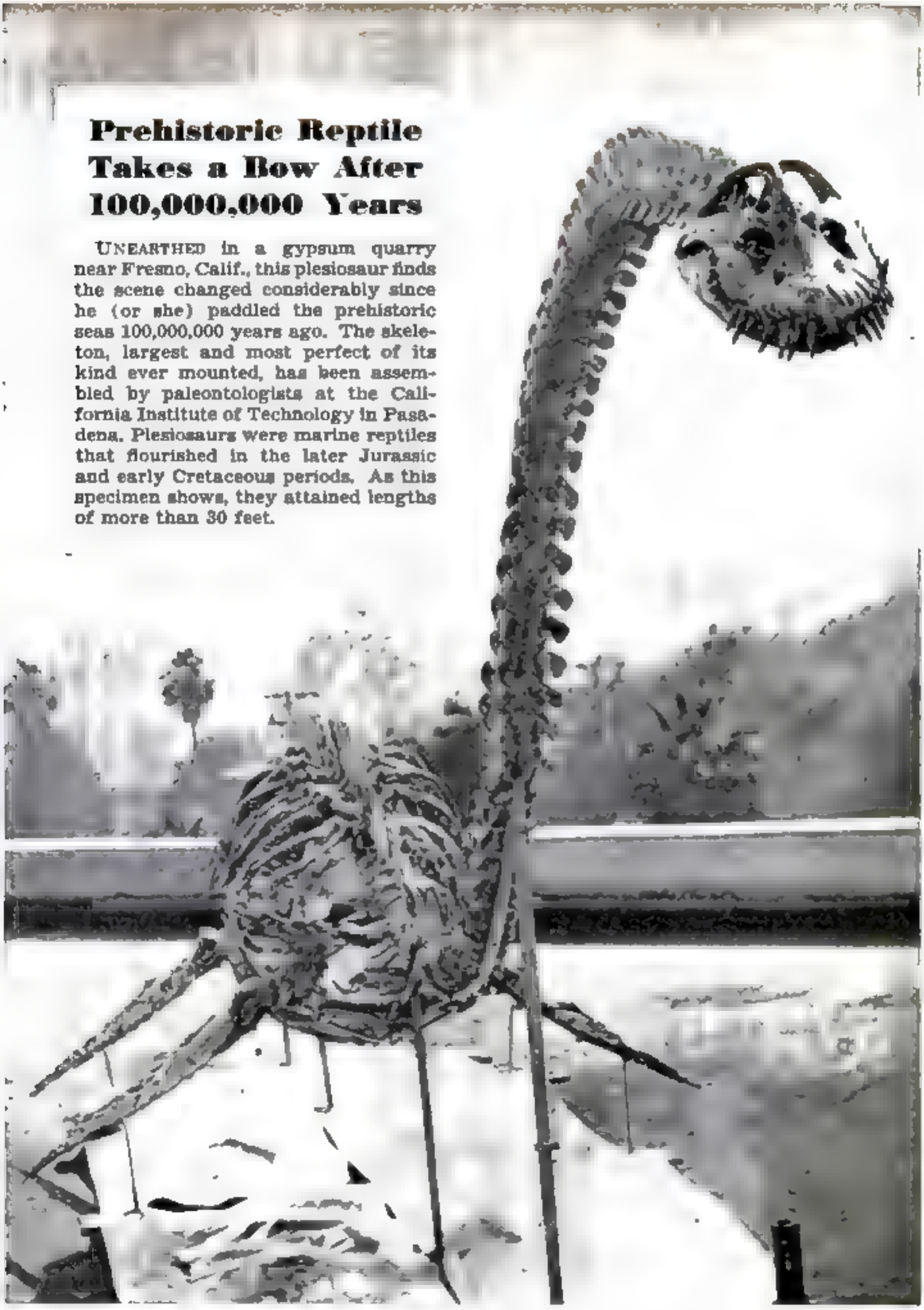
The Japanese have had a healthy respect for Russian arms ever since they clashed with the Red Army at Lake Khassan in 1938 and at Khalkin-Gol in Outer Mongolia in 1939. That, undoubtedly, is why they never dared to cross the Siberian border in the first two years of the German war, although the Nazis in Berlin must have called upon Tokyo for help.

As time goes on, as the Germans continue to take a beating in the West, Russia will get tougher in the East—not, I am sure, to help America, Great Britain, and China in their war with Japan, but to settle old scores that go back to that February day in 1904, when the Japanese jumped the Russian fleet.

Whichever country is first to attack, the ultimate outcome is clear. Japan will go down in defeat. Its cities will be bombed from Russian soil, undoubtedly with American planes. Its Kwantung Army will be driven from Manchukuo and almost certainly from Korea. Siberia will be a battlefield, and perhaps the graveyard of Japanese treachery and aggression.

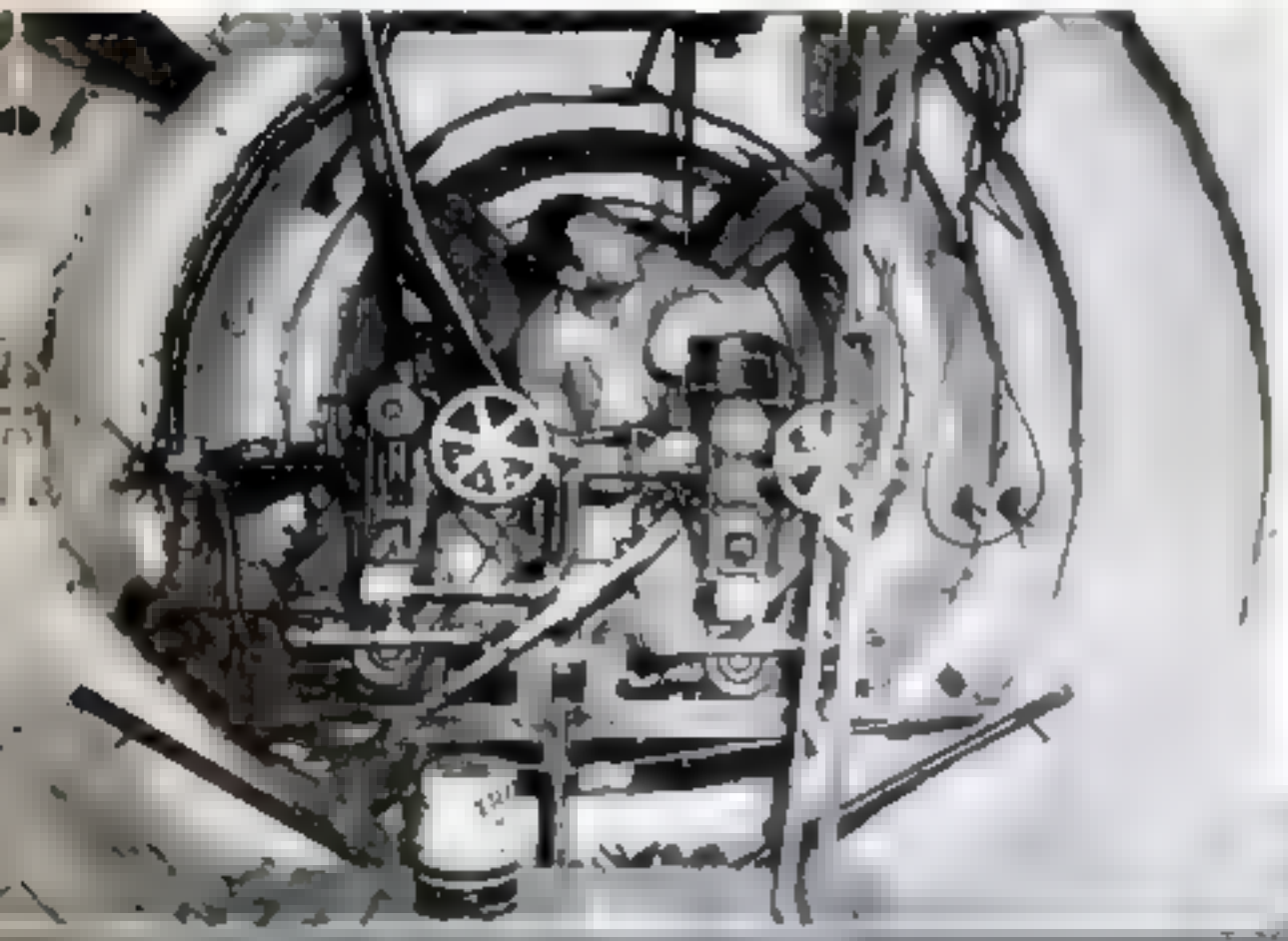
Prehistoric Reptile Takes a Bow After 100,000,000 Years

UNEARTHED in a gypsum quarry near Fresno, Calif., this plesiosaur finds the scene changed considerably since he (or she) paddled the prehistoric seas 100,000,000 years ago. The skeleton, largest and most perfect of its kind ever mounted, has been assembled by paleontologists at the California Institute of Technology in Pasadena. Plesiosaurs were marine reptiles that flourished in the later Jurassic and early Cretaceous periods. As this specimen shows, they attained lengths of more than 30 feet.

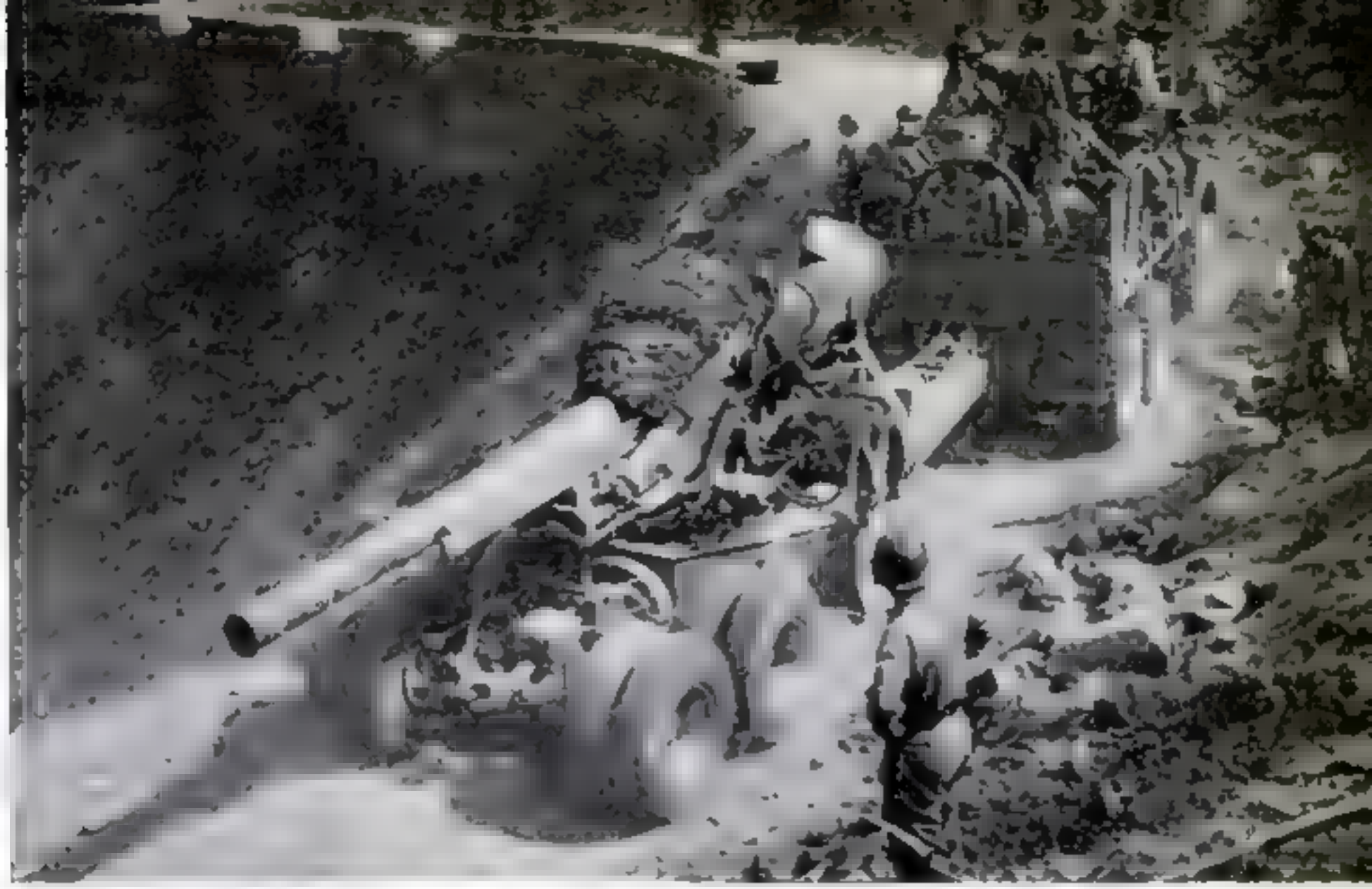


This is the largest and most perfect plesiosaur skeleton ever mounted. Assembled by paleontologists at California Tech, it shows the small head, long neck, and paddle legs of this genus of marine reptiles, which lived before mammals dominated the earth

TESTING TORPEDOES of the type carried by aircraft is simplified by a launching device used at the Naval Torpedo Station at Keyport, Wash. Constructed from salvaged metal by mechanics at the Keyport station, the device simulates the action of a low-flying torpedo plane in dropping its "tin fish" in the water near an enemy warship From a boxlike platform suspended above the water, an observer watches the performance of the torpedo as it plows its way toward its target



CONCRETE "SUBMARINES" eel-like craft that will operate almost completely submerged as carriers of troops and cargo through waters infested by real underwater raiders, are envisioned by Hal B. Hayes and Hal Williams, both of Hollywood, Calif. At the left, Hayes is seen inside a 124-foot model, which is shown below under test on San Francisco Bay. If trials are successful, plans call for construction of full-size, 10 000-ton vessels of this novel type. The photograph shows the two V-8 motors that drive the model.



"LONG TOM" AT THE FRONT. U. S. troops in action have had welcome support from the huge shells hurled by our 155-mm. long rifle. Here one of the American-designed big guns is creeping across a bad spot in a bomb-battered Sicilian mountain road, under the watchful eyes of engineer troops who have just cleared a path for it.

WOODEN BELLY TANKS are used by the Japanese to give extra fuel-carrying capacity to their planes. The two flimsy specimens shown at the left were found near the Munda airfield when that important New Georgia base was captured by the American forces. Apparently, the containers are made of molded plywood with some sort of gasolineproof lining—a poor job when compared with American aircraft fuel tanks designed for similar uses.

JEEP ON RAILS. Still another job for the Army's versatile quarter-ton is indicated by the picture below, which shows officers trying it out in the new role of switch engine somewhere in Australia. Fitted with flanged steel wheels, the jeep proves that it can move a long string of loaded freight cars. A dump trailer doubles as tender.

Hellcat Has the Zero's Number

SOMETHING that would "go upstairs faster"—that's what our Navy fighter pilots asked for. And they have it now, in a new Grumman plane that makes the lethal Wildcat look like a fireside tabby. First warplane to be based on combat experience in the Pacific, the F6F Hellcat was in quantity production before the first model flew.

While the Navy intends to let the Japs learn about the Hellcat the hard way, it is no secret that the new fighter has a wide margin over the Wildcat in speed, climb, guns, and armor. And, since the older plane chalked up a score of five to one against the fast but flimsy Zero, that's something.

The first full squadron of Hellcats was delivered to the Navy last December, and there were F6F's in the Marcus Island raid. They are going to the U. S. Marine Corps and the British Royal Navy, too.

LIFE LIGHTS, with which men who have to jump from a sinking ship at night can signal to rescue parties, are being manufactured by the Celanese Celluloid Corp., of New York. Made of Lumarith plastic, the lamp is equipped with a 30-inch lanyard at one end of which is a safety pin that is fastened to the life belt. At the other end is a clamp, by which the lamp can be attached to a seaman's clothing. The light is turned on by screwing tight the lamp's domed cap.

NONSKID SEA BOOTS with thick, cleated heels and traction soles are being made by the U. S. Rubber Company for the protection of submarine-crew members while they work on the slippery decks of their ships. The new waterproof boots are roomy enough for insoles and three pairs of wool socks.

They Cleared the Tracks for Victory!

The Iron Horse Saves the Day

America started the war under the threat of a transportation crisis . . . but then the railroads came through with a miracle.

By HICKMAN POWELL

TALK all you want about airplanes and electronics and motor transport—the part of this war effort which really rates a shout of amazement is the role played by the American railroads. The iron horse, which plowed the plains and spanned the mountains, was not what he used to be. For the last 20 years he had been getting creaky at the joints. To this Buck Rogers generation, millions of whom had never even ridden on a train, it seemed that he was inevitably doomed to go out to pasture. But here is the old horse now, snorting in the traces, hauling bigger loads and faster than anyone dreamed possible—least of all the railroad men who are making him do it.

With fewer miles of road than they had in 1918, with fewer employees, with 20,000 fewer locomotives and 600,000 fewer freight cars, the railroads of America in 1942 moved two thirds more ton-miles of freight than in 1918, and in 1943 are moving twice as much. In the first three months of this year, their passenger traffic, which had slumped off to a trickle in the 1930's, was virtually double what it was in the corresponding period of 1918. And this, mind you, is the accomplishment of a transportation system which in 1918 was almost at its peak and for two decades after that had been taking it on the chin from the

Careful maintenance has kept old rolling stock up to par on the heavy-duty job of moving war materials

Drawings by Stanley Rice

With less trackage, fewer employees and less rolling stock American railroads in 1942 hauled about two thirds more ton-miles of freight than they did in 1918 and today are hauling almost twice as much

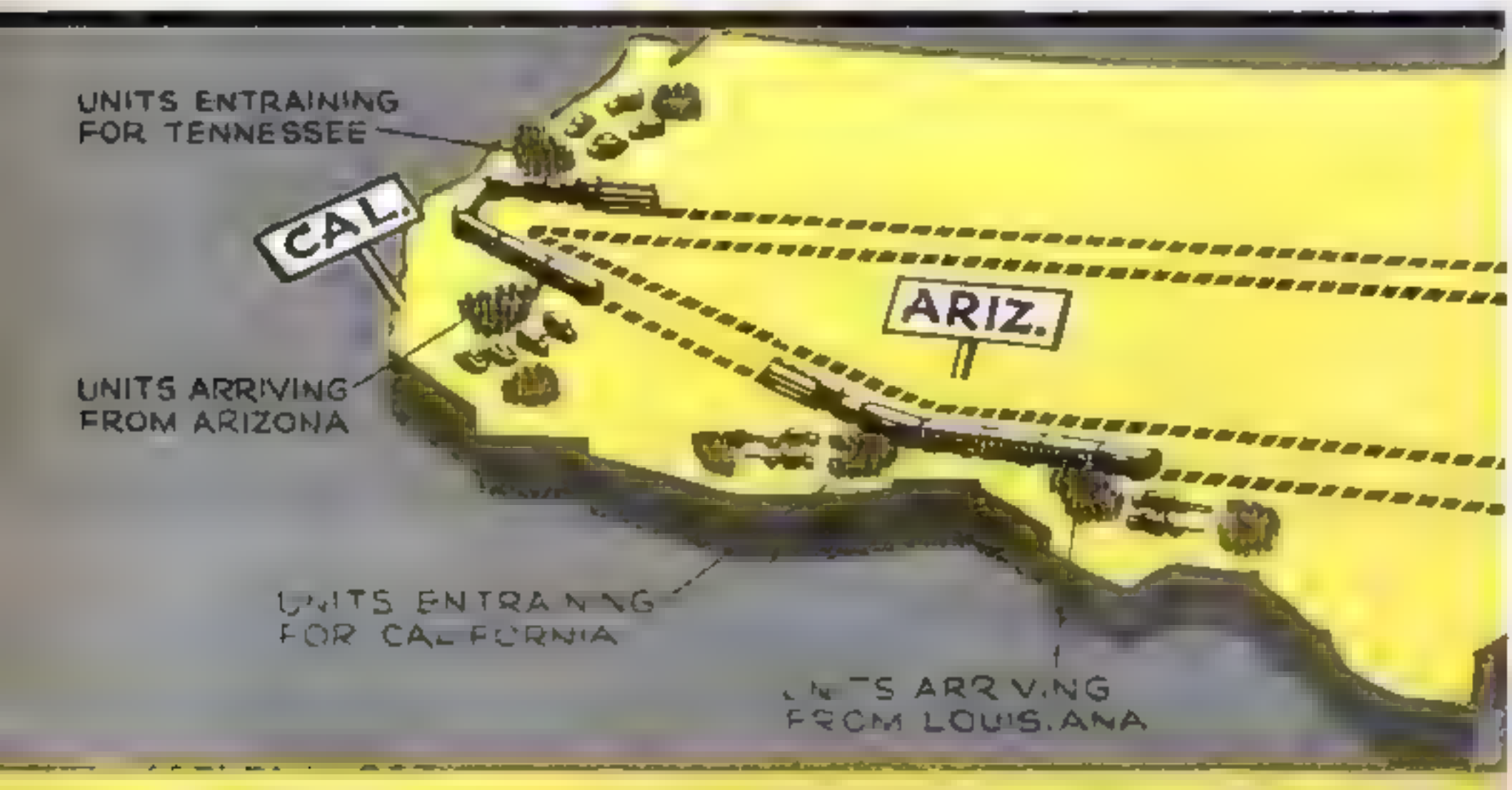
truck and bus competition of the motor age.

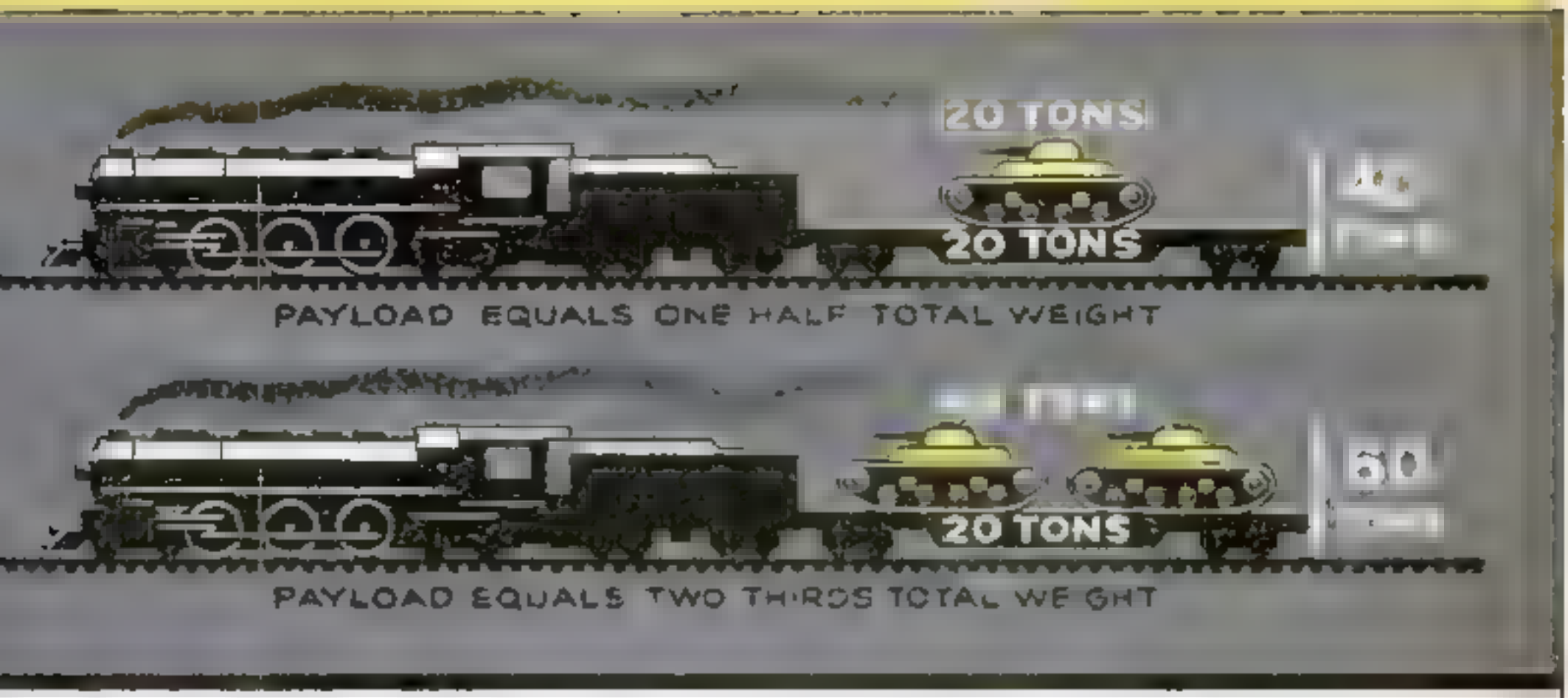
We Americans of the motor age, indeed, have only God and the railroads to thank for the fact that we avoided national disaster in 1942. Pearl Harbor was bad enough, but when the U-boat packs fell upon our defenseless oil tankers on the eastern seaboard they were striking much closer to the actual vitals of the country. The whole industrial Northeast was dependent on gasoline, and the devastating success of the submarine was cutting off that supply.

It was the railroads that came to the rescue and averted the collapse of motor transport. A fleet of 50,000 old tank cars used by the oil companies for odd jobs of storage and short hauling—were put to work, hitched into solid trains, and shuttled back and forth across the country on fast daily schedules as precise as passenger service. Railroad men had been laughed at when they first thought they might be able to move 200,000 barrels a day in this fashion and soon it was proved how wrong they were. For by this last summer the old tank cars—stopping occasionally to get new wheels—were moving five times that much!

The East still starved for gas. But that was because the railroads had been so successful that the Army and Navy dared to

Far-sighted management has also seen to it that cars don't sit around for days waiting to be unloaded that they are kept in first-rate repair by the company on whose rails they happen to be rolling at the





One of the means by which the railroads have accomplished their miracle of transportation is by seeing to it that cars are loaded to capacity whenever possible. Above shows how this increases payload ratio

draw on eastern gas for their fighting supply.

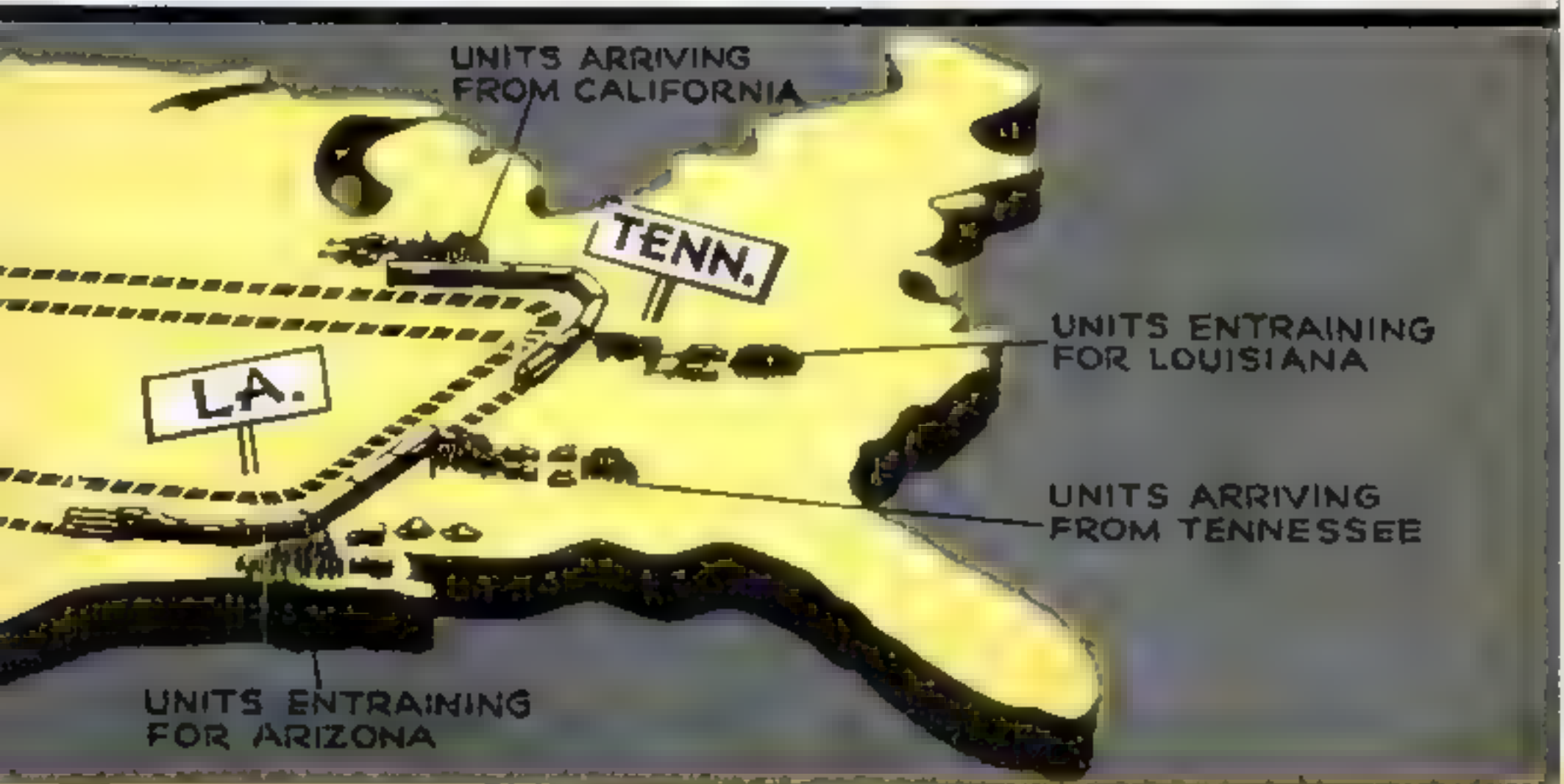
While this battle of oil was being won, the loss of Malay rubber to Japan threw another great burden on the rails. We have managed to get by on our tire supply, because railways have absorbed the great expansion of traffic that would have been on rubber.

Transportation is a fundamental necessity in any war. Sea transport, because it is under attack, and air transport, because it is new, have had the spotlight; but the railroads have handled a far heavier load, because they move each item many times.

From mine to smelter, to mill, to part factory, to assembly plant, our goods move from raw material to completion as engines of war, making each move by rail in a steady stream on which the flow of production is utterly dependent. Once assembled, the war machine goes to troops by rail, then moves with troops from training camp to maneuver area, back to training camp, and again to port of embarkation. Then, on its arrival abroad, the railroads resume the burden.

All the vast new factories, munitions depots, and training camps, springing up in sections where industry and population had been small, have been built and supplied with men and materials brought by rail. Freight traffic, which formerly moved pre-

moment, and that they never roll home empty. Typical of today's efficiency is the device, illustrated below, whereby cars moving troops are scheduled to receive a load as soon as they have discharged one



dominantly eastward through yards and terminals built to take it, now runs west in almost equal flow—to the great Pacific ports of embarkation, to the plane factories of California, to the shipyards of the Northwest. Why, for just one of Kaiser's Liberty ships, it takes a trainload of steel, which must arrive on time. And then the train returns, carrying copper or timber which ordinarily would have moved via the Panama Canal, now closed to merchant trade.

All this has gone on while trains rushed oil to the East; while millions of travelers, deprived of rubber, have rushed to the railroads; and while troop movements have reached a fantastic level. Where soldiers of 1918 moved perhaps three times by rail while training, today's troops move six to eight times, on trips averaging 800 miles, often spanning the continent. Transportation has been used prodigally, because the railroads could provide it. And the remarkable thing is that they provide it with almost no new equipment. Sidings have been lengthened to hold longer trains, intricate electric traffic controls have been installed to accommodate far more trains on a single track, yards have been built. But in general the rolling stock is little more than it was in quiet 1939. The new streamlined trains have kept running at full speed. The new 4,500-horsepower Diesels have hauled away unceasingly, dragging great loads across the western mountains. But a great part of the increase has been through the intensive use of equipment which had seemed almost ready for discard.

Intensive management has done the trick. For instance, it takes about 1,300 cars—passenger and freight—to move an armored division. A few years ago such equipment would have been immobilized for days or weeks after making a special run. But last spring, within a period of six weeks, one set of equipment moved seven divisions, on trips of several thousand miles.

First the trains, carrying troops with their tanks, moved one division from Fort Knox down to Camp Polk, in Louisiana. As each train unloaded, it picked up a unit from another division, bound for the Arizona desert area. From then on to California, back to the Tennessee maneuver area, again to Louisiana and the desert, and back to California and Tennessee. That series of movements, which could be accomplished only by careful advance planning and scheduling, is one of the prize accomplishments of the military transportation section of the Association of American Railroads, a civilian unit quartered in the Pentagon Building outside of Washington, where it functions virtually as a part of the Army, moving more than 2,500 special trains a month.

At one time during the First World War there were tied up in eastern terminals and yards more than 200,000 freight cars, far more than could be unloaded, while other parts of the country were suffering from car shortages. The job had been botched, so the Government took over the railroads and botched it some more. But all the fault was not on the railroads or the Government. Much of it was due to faulty planning by shippers.

The railroads and the Government both had more foresight this time. Locomotive power has been conserved by running longer trains, by keeping engines on the road for longer runs, and by loading cars more heavily. When a 20-ton car is loaded with 20 tons of freight, only half of what the engine pulls is payload. But load that car to capacity of 40 tons or more, and the locomotive is pulling twice as much freight while its total load is increased only by one half.

All purely military transportation—of troops, Army freight, and goods for Lend-Lease—is under direction of the Army Transportation Corps, set up after Pearl Harbor as a part of the Services of Supply, under command of Major General Charles P. Gross. In this country, the actual work is done by the roads themselves, co-operating under the leadership of their Association of American Railroads.

But once overseas, the Army takes control and its own railroad troops man the trains, in co-operation with our allies. Long before the war our railroad military units were set up as part of the Army reserves, entire skeleton outfits drawn from individual railways, with operating battalions modeled after the organization division, and shop and maintenance battalions.

On three rail systems across the north of Africa today American railroad men in uniform are working with a motley collection of French civilians, Algerians, and British soldiers, working with everything from the oldest of narrow-gauge engines to the newest of American cars and locomotives, uncrated and assembled on the spot. And as the African and Italian campaigns show, they have been getting results. Farther east, other American railway troops work in partnership with Persians, running the trans-Iranian Railway, from the Persian Gulf cross the mountains to Russia, moving the great flood of Lend-Lease supplies.

Over there they have new cars and new locomotives, thousands of them where they are needed most, and there will be plenty more when the troops move in on Europe. They are moving the stuff that will win the war; and whether or not they talk the same language, whether they are in uniform or not, they all understand each other on that. For they are all railroad men.

A flyer wearing the new A-14 rubber face mask used with the demand oxygen system. Around its edge the mask seats against the skin in an airtight seal

Something New in Fashions

With the new demand oxygen mask, our flyers challenge the Axis enemy at any altitude.

By STEWART ROUSE

Drawings by the author. Photographs courtesy of U. S. Army Air Forces.

YEARS ago, our Army developed the first aerial oxygen equipment, along with its first high-altitude planes. This "free-flow" system worked well enough in the earlier days of military flying; the oxygen was fed from the regulator into the mask, and the pilot turned a handle to increase the flow as he gained altitude.

But in a modern warplane, under combat conditions, flyers have too much else to do. That's why the Aero-Medical Laboratory at Wright Field was set the task of designing oxygen equipment that would "do its own thinking." The solution they have come through with is a honey—the best oxygen system in the world, according to the Air Surgeon General, whose business it is to know.

It's called the "demand" system, because it automatically adjusts its flow to the demand of the flyer's body at any altitude. It gives him air without extra oxygen at ground levels. As he ascends into thinner atmosphere, it automatically begins to add oxygen to the air he breathes. And, it increases the proportion of oxygen as he goes up, until at 30,000 feet—when he needs it most—he's getting pure oxygen.

On night flight, simple adjustments vary the working of the demand system so that the flyer gets oxygen, in increasing quantities, all the way from the ground up. For, research has shown that lack of oxygen is a major cause of poor night vision. If oxygen

ADVANTAGES OF DEMAND OXYGEN SYSTEM

It provides the user with the proper amount of oxygen at all altitudes and under all conditions up to 38 000 feet while 'free flow' system [right] is inadequate above 30 000 feet if physical activity is required. Action is fully automatic, needing no adjustments during flight. It is less subject to failure at low temperatures. Saves oxygen by delivering it only when the user breathes in and only as much as is needed. Suspension of the mask gives a much more satisfactory and secure fit under abnormal pulls in sharp turns

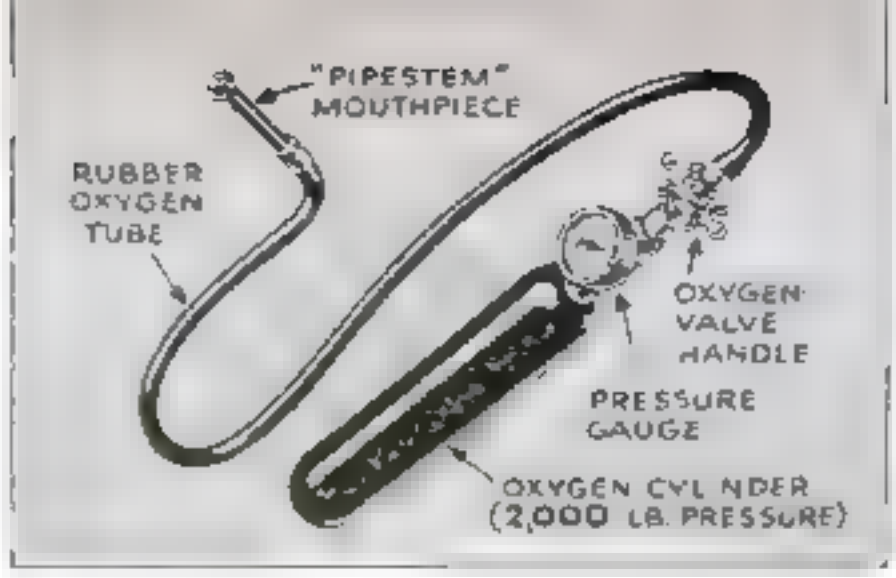
isn't used, night-vision efficiency drops with altitude. Effects are noted as low as 5,000 feet.

The "thinking" oxygen equipment looks complex but, in principle, it is relatively simple. The heart of the apparatus is the regulator, which gets its oxygen from specially designed, light but strong cylinders through a supply line or "trunk line." Air comes into the regulator through an air port which closes automatically at 30,000 feet. From the ground to 30,000 feet, the proportions of air and oxygen admitted to the automatic mixing regulator are controlled by a tiny aneroid bellows control, similar to that in a barometer, operating two valves. As the outside air pressure decreases with altitude, one of these valves opens the oxygen supply inlet farther and farther; the other closes the air inlet correspondingly.

One of the main drawbacks of the old-style equipment which the new regulator replaces was its tendency to waste oxygen. The older types supplied oxygen at all times. But the automatic regulator now incorporates a device which cuts off the oxygen flow every time the flyer exhales and renews it with each inhalation. This device, a little diaphragm working a valve, operates on the differential of pressure induced by the reversal of the flyer's breathing. When he breathes in, the diaphragm flips to one side and a little lever linkage opens the oxygen valve. But when he starts to exhale, the pressure moves the diaphragm and thus shuts off the oxygen-flow valve.

Sometimes, in flight, the pilot may want a momentary "shot" of oxygen. He gets this through a flip of the finger on the auto-mix button of the regulator. This cuts off the air flow when turned to the "off" position and thus gives pure oxygen at any altitude. If, for some reason, the mechanism should fail to function, there is another little handle labeled "Emergency"; this by-passes the entire regulator mechanism and causes pure oxygen to flow directly into the mask feed hose.

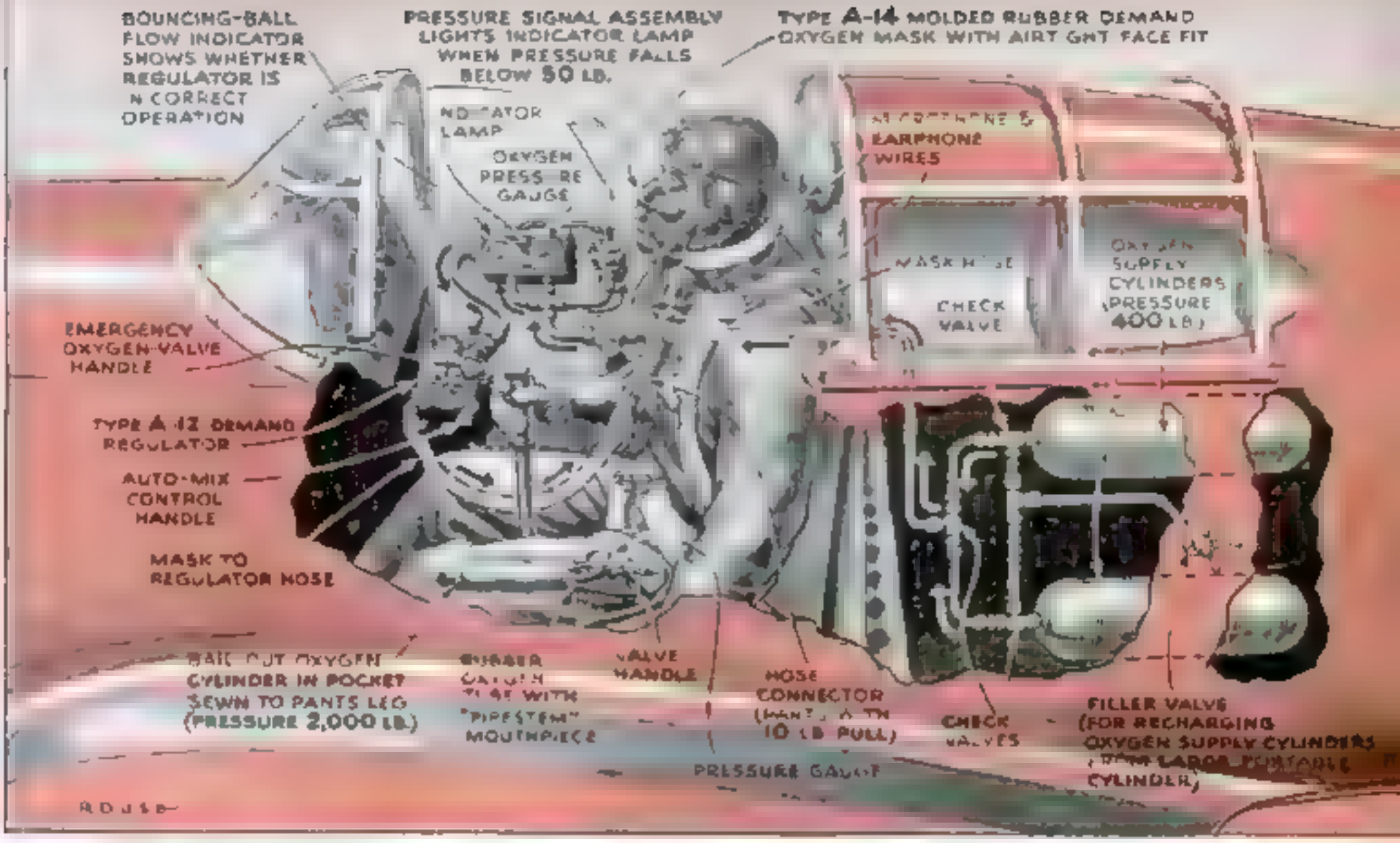
(Continued)



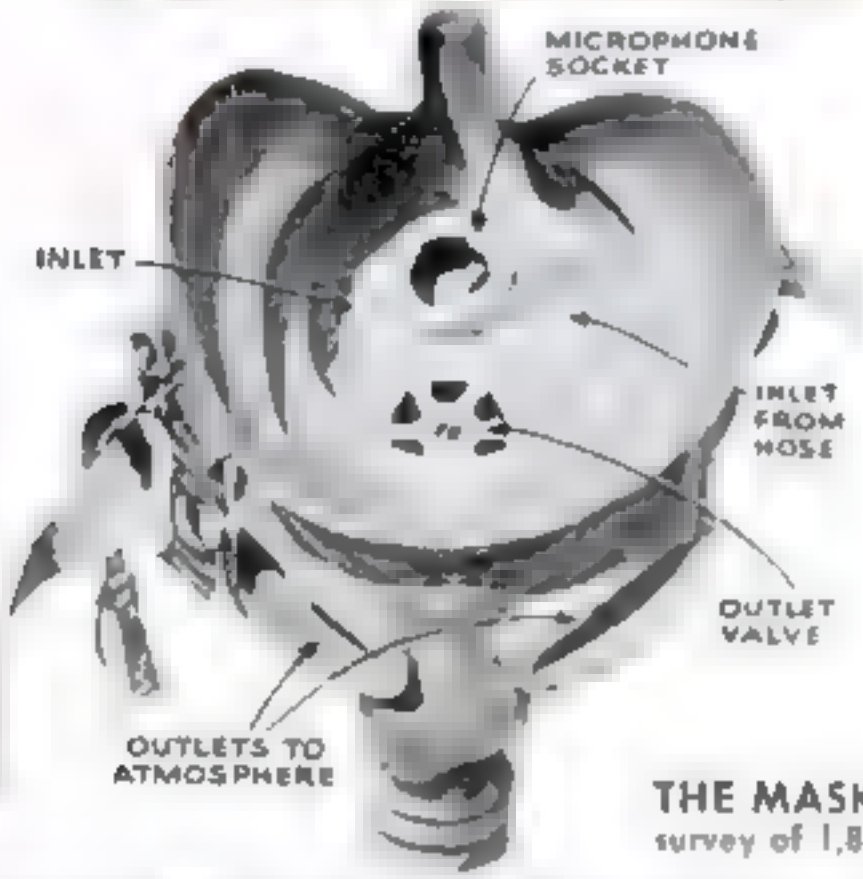
BAIL-OUT BOTTLE. If he has to jump, the airman discards his mask and sucks oxygen through a tube from a cylinder in a pocket of a trouser leg

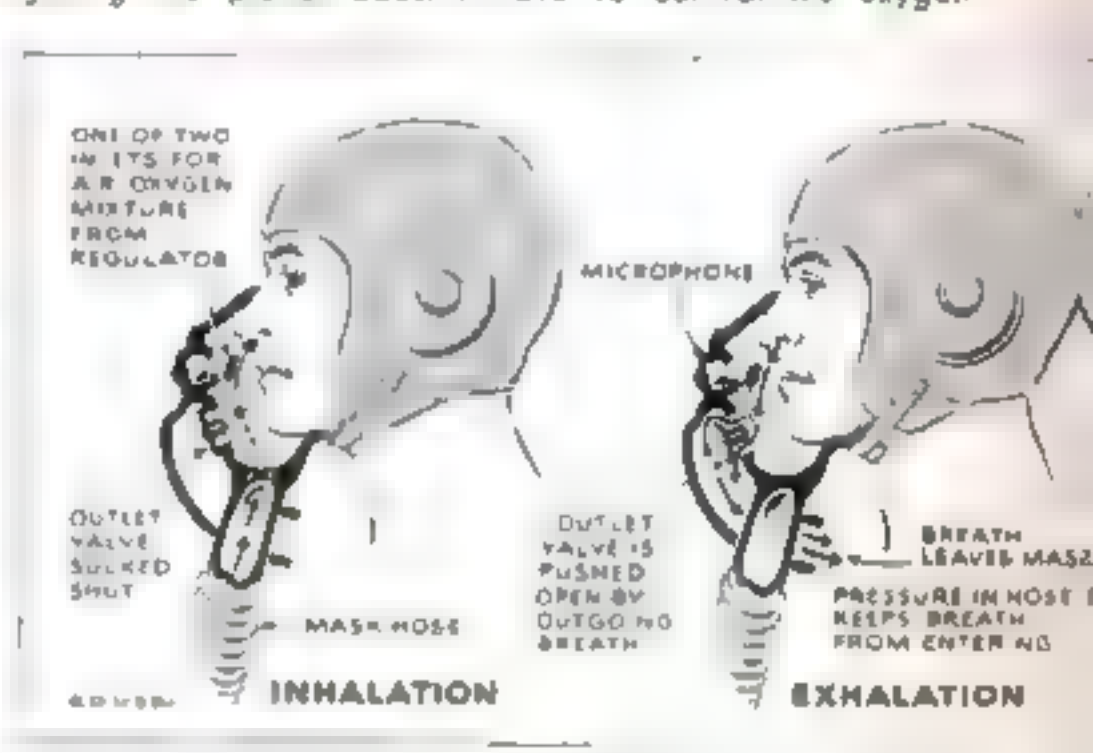
"WALK-AROUND" GIVES FLYER FREEDOM OF PLANE

To leave his station, a crew member in a bomber or cargo plane disconnects his mask hose from the demand-system regulator and plugs it into his walk-around. On returning to his station, he recharges the bottle as shown at the right. This operation is also illustrated in the Air Forces photograph on this month's cover



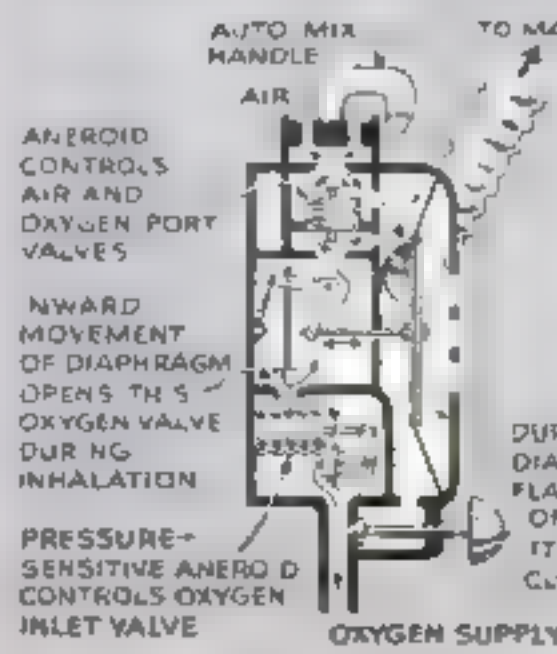
DEMAND SYSTEM is seen in detail in this drawing which shows it installed in a fighter plane. The pilot who has plenty to do in flying and fighting the plane doesn't have to control his oxygen



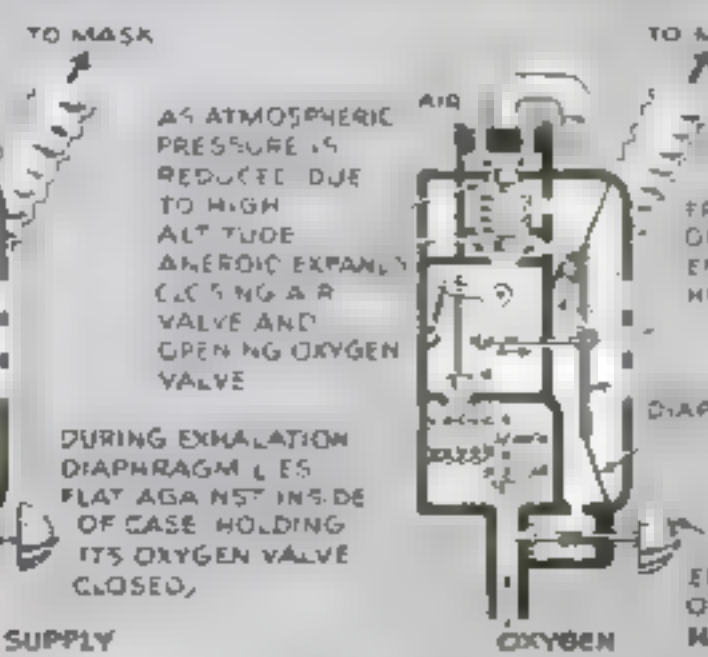


THE MASK is a masterpiece of design based on an anthropolog ca survey of 1,871 aviation cadets (P. S. M., March 43, p. 96) to assure fit

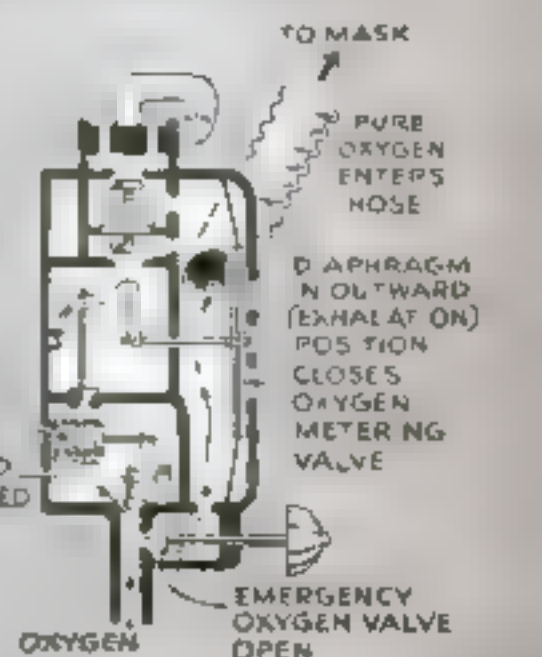
REGULATOR IS HEART OF DEMAND OXYGEN SYSTEM



REGULATOR ACTION AT 10,000 FT DURING INHALATION

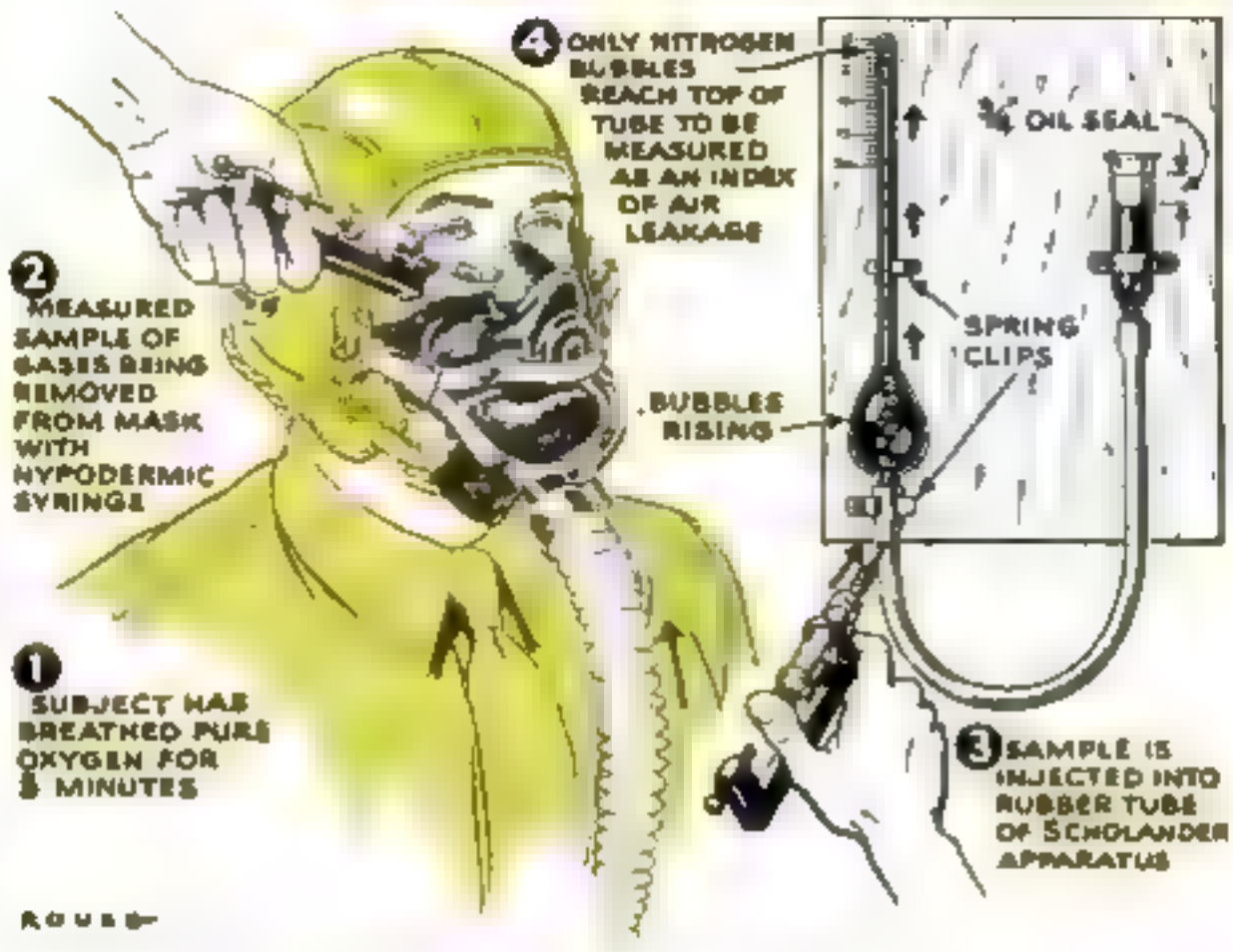


REGULATOR ACTION AT 30,000 FT. DURING INHALATION



HOW EMERGENCY VALVE FEEDS PURE OXYGEN

CONSTANT TESTING SAFEGUARDS FLYERS



Mask-testing apparatus at left is filled with pyrogallic acid (which absorbs oxygen) and potassium hydroxide (which absorbs carbon dioxide and water vapor). Another safety device is the oxygen flow indicator, above, which shows if system is working

The mask of the new equipment also differs substantially from the type formerly used. The oxygen-air mixture flows directly into the mask through a flexible hose which divides into two lines as it enters the mask, each entry being opposite a nostril. Just below the tiny microphone, at mouth level, is the exit valve. When the flyer exhales, the foul air passes through this valve. The pressure of the oxygen-air mixture in the inlet system prevents the foul air from running down the inlet pipe and contaminating the supply. When the man inhales, the outlet valve—using a soft rubber washer—flaps shut and prevents an inflow of outside air. No low-oxygen-content outside air can enter.

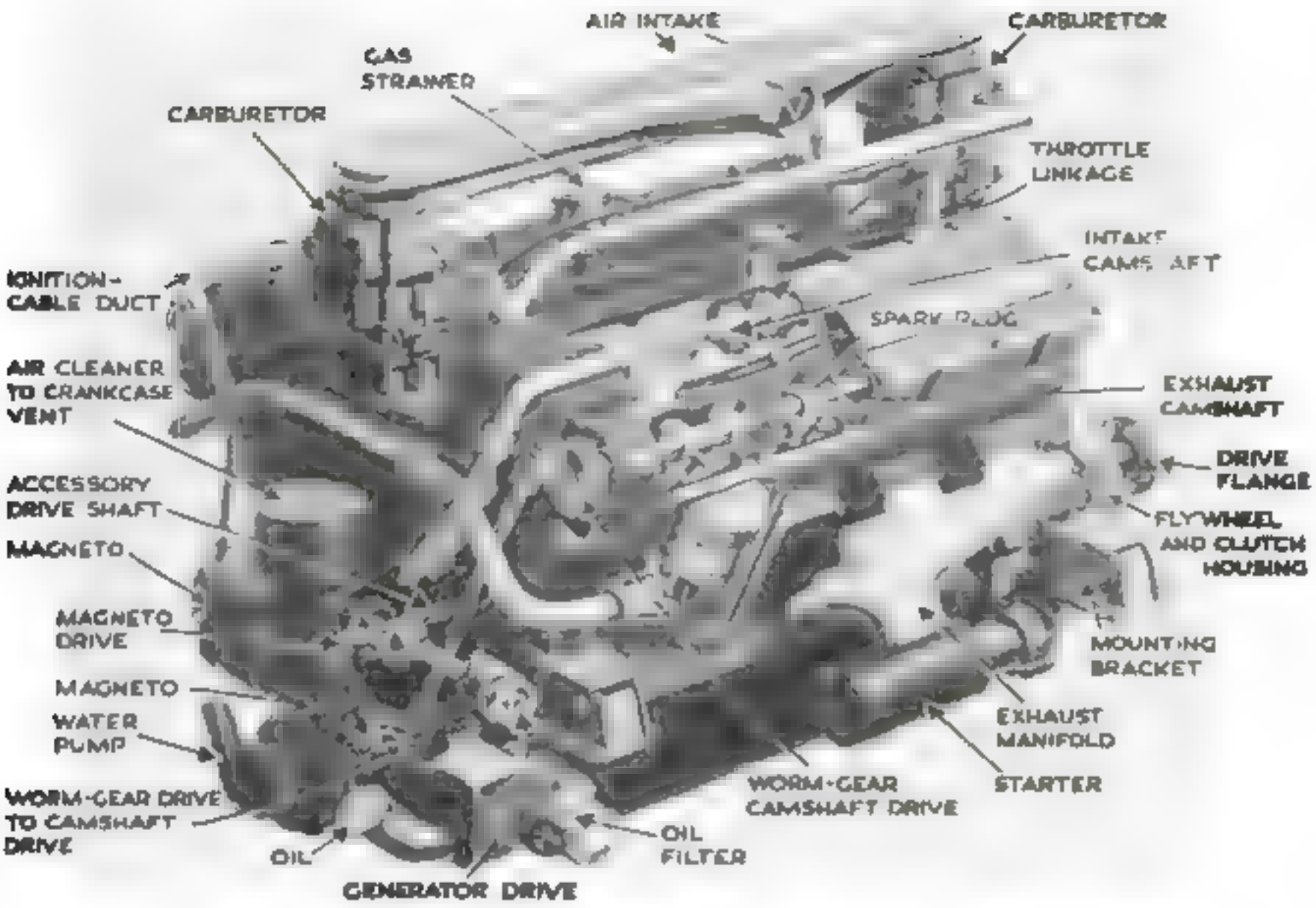
The outlet valve feeds into a duct which carries exhaust air down to the chin and neck. This prevents fogging of goggles.

The new system is equipped with a number of safety and convenience devices. A bouncing-ball flow indicator, set at the side of the pilot's cockpit, tells whether the entire system is in correct operation. This gadget is so arranged that a little ball, within a glass pipe, bounces every time the user of the mask breathes. If the ball should fail to bounce, he would know that he is not getting the proper flow of air-oxygen mixture and would open the emergency valve. When pressure in the oxygen system as a whole drops below 50 pounds—that is, when only one seventh of the total supply remains—a lamp lights up near the bouncing ball. This tells the flyers that they'd better get the plane down below 10,000 feet pretty soon, before they run out of oxygen. Sometimes a blinker device, like a winking human eye, is used instead of the bouncing ball, to show whether the regulator is in perfect operation.

On large planes—bombers and transports—each flyer has his own regulator and mask, plugging it into his station on the trunk-line oxygen-distribution system. Often, however, especially in battle the flyers have to walk around from one spot to another. For this purpose, each station has a small portable oxygen cylinder known as a "walk-around bottle." The flyer can plug this onto his mask hose when he wants to roam, replugging into the central system when he returns to his station. The bottle, when not in use, is recharged by means of a hose at the flyer's station.

Each crew member also has a small bail-out cylinder charged with oxygen under very high pressure. He wears this in a pocket in a trouser leg. If forced to parachute, he takes off his mask, puts the pipe-stem bit of the bail-out hose into his mouth, turns the valve, and jumps. He will have enough oxygen for his trip to earth.

Oxygen to supply the demand system is stored in light but very strong cylinders clamped to structural members of the plane. These are connected to a manifold or linkage of small-diameter pipes, so that all the cylinders deliver their oxygen at equal pressure to the trunk-line pipe, which passes through the fuselage and reaches each crew station. Every cylinder has its own check valve, so that if an enemy bullet punctures it the oxygen cannot blow back through the damaged cylinder and be lost. Cylinders are recharged as necessary from portable high-pressure cylinders carried on a truck, through a filler valve extending outside the fuselage.

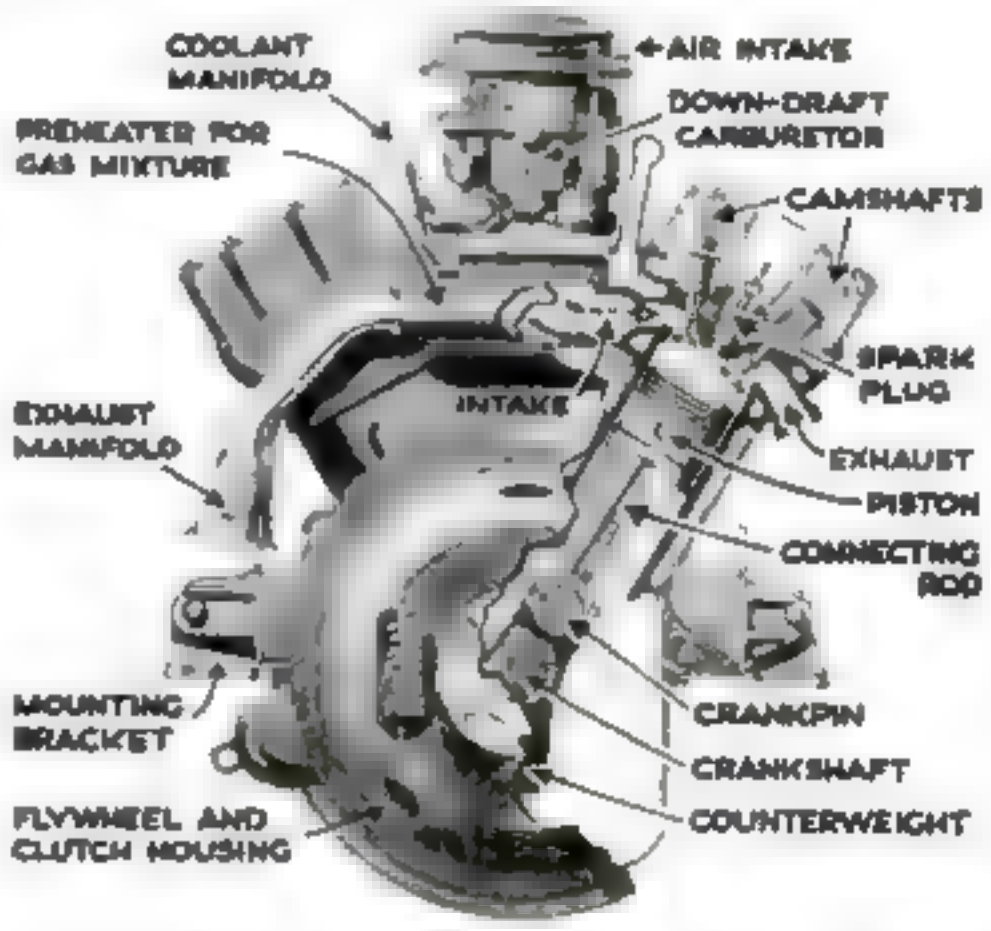


Our Medium Tanks Get a New Engine with Lots of Zip

OFF Ford assembly lines has come a tank engine that our fighting men hail as an Axis beater. It has what it takes to triumph in armored warfare—speed, dependability, and "zip." What's more, its compact construction makes it simple to service, and mass production is possible with a minimum change of available machinery. It powers our medium tanks and tank destroyers.

Ford and Army Ordnance engineers developed this engine. Its basic specifications were taken from a 12-cylinder aircraft engine of proved merit. The engineers cut it to eight cylinders, added clutch and flywheel, and altered the fuel, ignition and lubrication systems. The result is a liquid-cooled V-type engine weighing approximately 1,500 pounds and developing 500 horsepower at 2,000 revolutions a minute.

Some of its innovations: Crankshaft and flywheel are cast instead of forged; push rods are of one piece of copper-silicon steel; central power drive unit operates camshafts, water pump, oil pump, magneto, fan, and generator, simplifying service; centrifugally cast cylinder liners assure greater strength and longer wear.



End view of new tank engine with cut-away of cylinder assembly. General view at top shows other details, including the accessory drive that simplifies servicing

1

Natural Brazilian rock crystals, which are almost pure silica, are the raw material for transparent fused quartz that has found wide use in industry

2

Crushed into fine pieces, the crystals are packed into a crucible, put in an electric furnace, and heated to the fusing point of 3,200 degrees F.

FUSED QUARTZ REPLACES STEEL AND GLASS

Photographs Courtesy General Electric Company

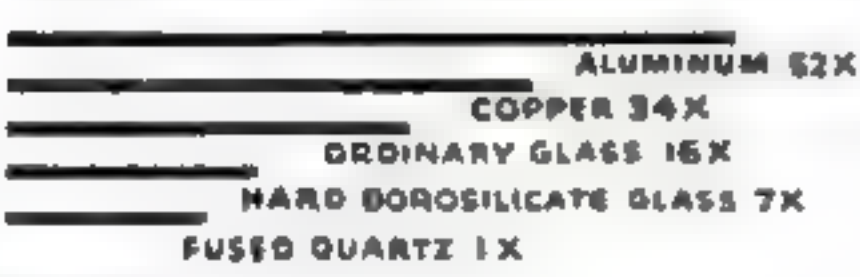
PRECISION gauges of fused quartz, used to test parts for airplane engines, now release tons of the finest tool steel for other war needs. This new application stems from one of the many remarkable properties that General Electric research workers have found in melted and solidified rock crystal.

Because fused quartz reacts almost negligibly to changes in temperature, it proves ideal for standards of length and of angles. Its high melting point, exceeding that of glass by some 1,200 degrees F., especially suits it for use in high-temperature vacuum tubes for lighting airfields. Probably the flattest things in the world are 10-inch disks of the material, ground for optical purposes by the National Bureau of Standards. Their surfaces, 1½ inches apart, vary less than 4/10,000,000 of an inch from perfect planes.

While healthful ultraviolet rays of sunlight cannot pass through glass, fused quartz transmits them freely. Some day the material may be made cheaply enough for windowpanes. Already, germ-killing rays of ultraviolet light are being emitted by sterilizing lamps employing fused-quartz tubes, and the infrared rays called radiant heat are as easily transmitted.

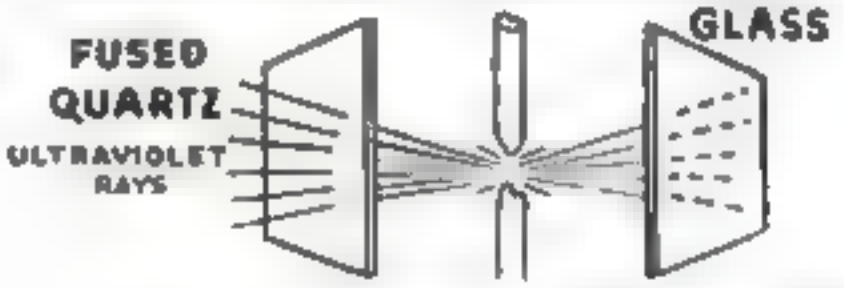
EXPANSION

Its low coefficient makes fused quartz ideal for fine gauges and optical lenses and flats



LIGHT TRANSMISSION

Ultraviolet rays of the sun or a lamp pass through fused quartz, but glass halts them



10

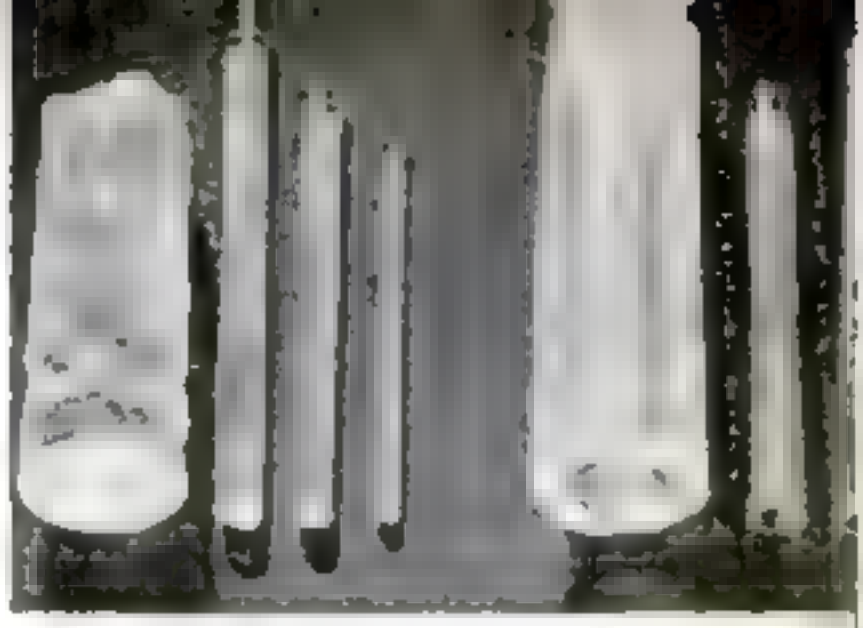
One end stuck into a furnace, a fused-quartz rod "pipes" sufficient heat to light a cigarette, yet its sides remain cool enough to be held by hand

9

Laboratory ware of clear and translucent fused quartz has a high melting point, low coefficient of expansion, and very great resistance to acids

3

After it has cooled off, the ingot into which the mass of crushed quartz crystals has been fused is lifted out of the furnace for further processing



4

Rods are made from solid ingots, and tubes are worked from hollow ones. Both forms of ingots and fused-quartz rods and tubes are shown above

IN NEW USES

Drafts or spattering of molten metal from the arc lamps in motion-picture projectors sometimes crack their glass condensing lenses. Quartz lenses now eliminate the trouble. Resistance of fused quartz to chemical corrosion adapts it especially to laboratory flasks, beakers, and test tubes.

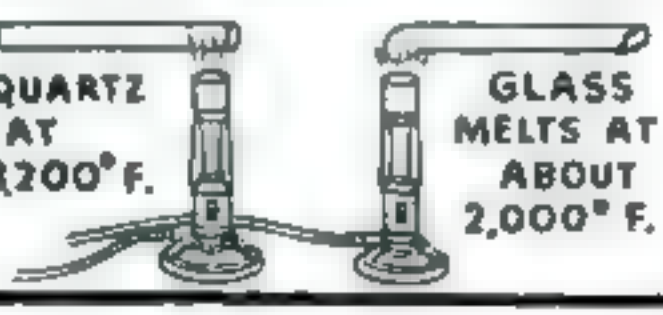
Though fused quartz has been familiar to scientists for more than a century, until recently it has been used mostly in the laboratory Natural quartz crystals are melted in an electric furnace to make the transparent material, and a selected grade of pure sand is used for a less expensive translucent or opaque variety.

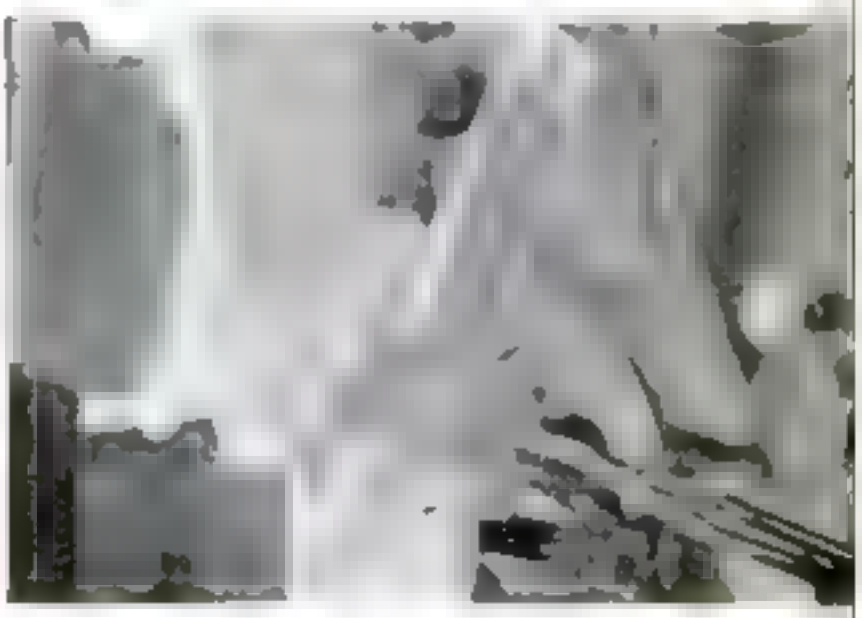
5

These fused-quartz blanks, 12 inches in diameter, will be made into 10-inch optical flats varying less than 4/10,000,000 inch from a true plane

HEAT RESISTANCE

Fused quartz is often used continuously at 1,800 degrees F. and intermittently at 2,300





6

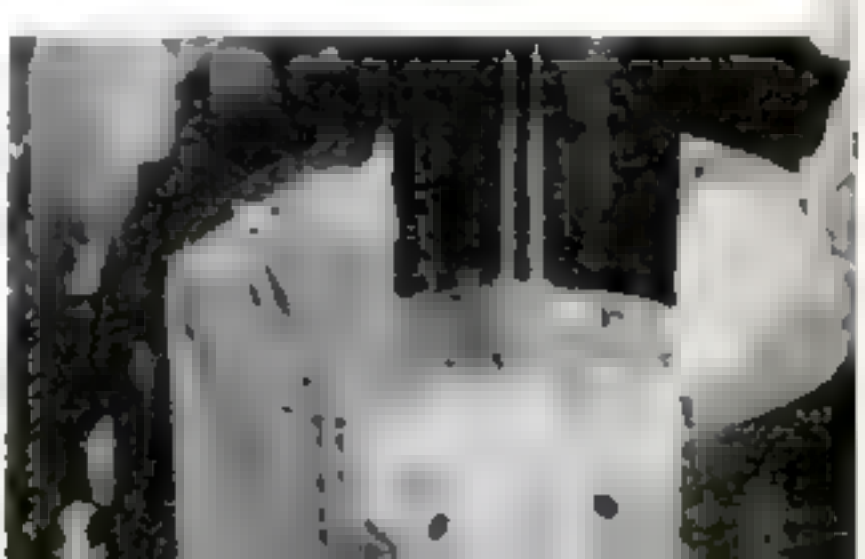
When a hollow fused-quartz ingot is worked into a tube, it is first placed in a furnace where it is again heated—this time to make it pliable

8

Because of a high resistance to thermal shock and freedom from distortion caused by heat of friction, fused quartz is ground and lapped faster than glass

7

Then, while part of the ingot remains in the furnace, it is drawn into a long tube of the diameter required. The solid ingots are worked into rods in the same way



How to Ditch a Fortress

What happens to the crew of one of Uncle Sam's big land bombers when it is forced down on the sea? It may be only a matter of seconds before the plane sinks, but every man knows his job and does it.

WHEN the order, "Prepare to ditch," comes over the interphone system of one of our big bombers, 30 seconds may mean the difference between life and death for the crew. For that warning, sounded by the pilot, is notice that the big land plane is being forced down on the sea, and 30 seconds afloat without seaplane landing gear may be all that can be expected even under the most favorable conditions.

So well trained are our bomber crews, though, that these emergency landings on

water have lost much of their hazard, at least insofar as it relates to loss of life or injury in the actual landing. Each man knows his station, and he goes to it, ready to act instantly with the final impact of the plane on the water. Each has his specific duty to perform, and he does it without hesitation and without delay so that he and his mates will be assured of at least a fair chance of survival in their life rafts. In addition, each man also knows duties of the others in the crew so that no hitch will occur should any be too seriously injured to carry out his part.

Specific instructions, known officially as the "ditching procedure," have been prepared by the Boeing Aircraft Company and the Army Air Forces. The steps apply particularly to Boeing's big Flying Fortresses, but in general they are also followed for a water landing made by any other multimotored land plane. Illustrations and instructions from the "ditching procedure" are given on this and the preceding page.

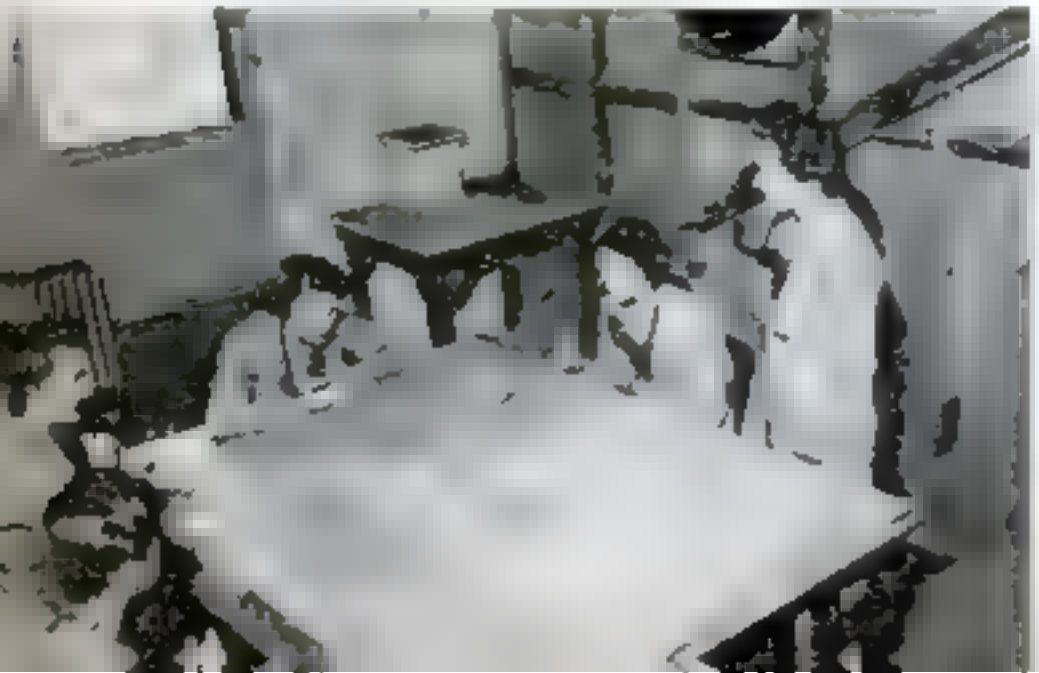
1 This huge floor at the Army Air Forces School of Applied Tactics, Orlando, Fla., is a map of the China coast. To train officers in air defense, electric "jeeps" (left) roll over it representing bombers

Electric "Jeeps" Aid Air-Defense Training

2 Wac "spotters" stationed in balcony posts on the four walls take sights on an invader and report its course, speed, height, and other data

3 At the main filter board, duplicating equipment of a defense center, this information is used to determine the objective and arrival time of attackers

4 From the plotting table, orders are flashed to "interceptor bases" on the big map floor, giving courses on which enemy can be headed off

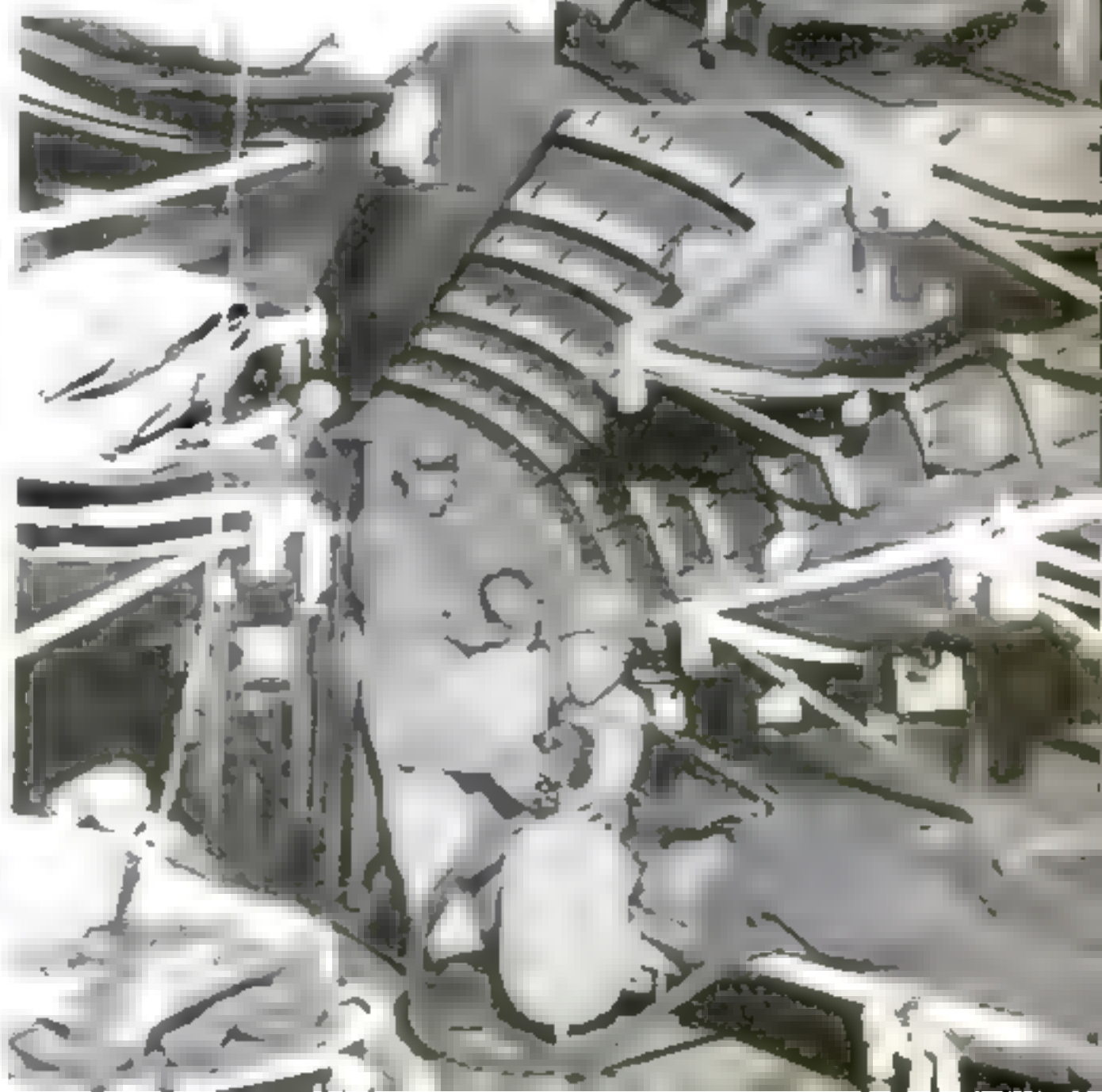


5 Getting orders on a walkie-talkie, a Wac sets the controls of her interceptor "jeep." It should meet the "bomber" before the latter hits its target

CARGO PLANES DOUBLE AS AIR AMBULANCES

FLYING AMBULANCES, converted from giant transports that carry men and matériel into battle, are being used to speed the wounded to base hospitals. Cargo planes going up to the front, they are hospital ships coming back. Many are big C-47's like that shown above at a demonstration at the School of Applied Tactics in Florida

STRETCHER SUPPORTS that can be stored under the floor boards when not in use are easily attached to the bulkheads of the fuselage, as in the photo at right. Stretchers are held on with clamps so they will not be thrown off if the plane goes into a sharp manouver. Medical equipment, under the control of a flight surgeon, is complete, including oxygen tanks, as shown below, and all other necessities for sustaining life on the flight to the base hospital. Soldiers' gas masks, with filter removed, are used for oxygen masks

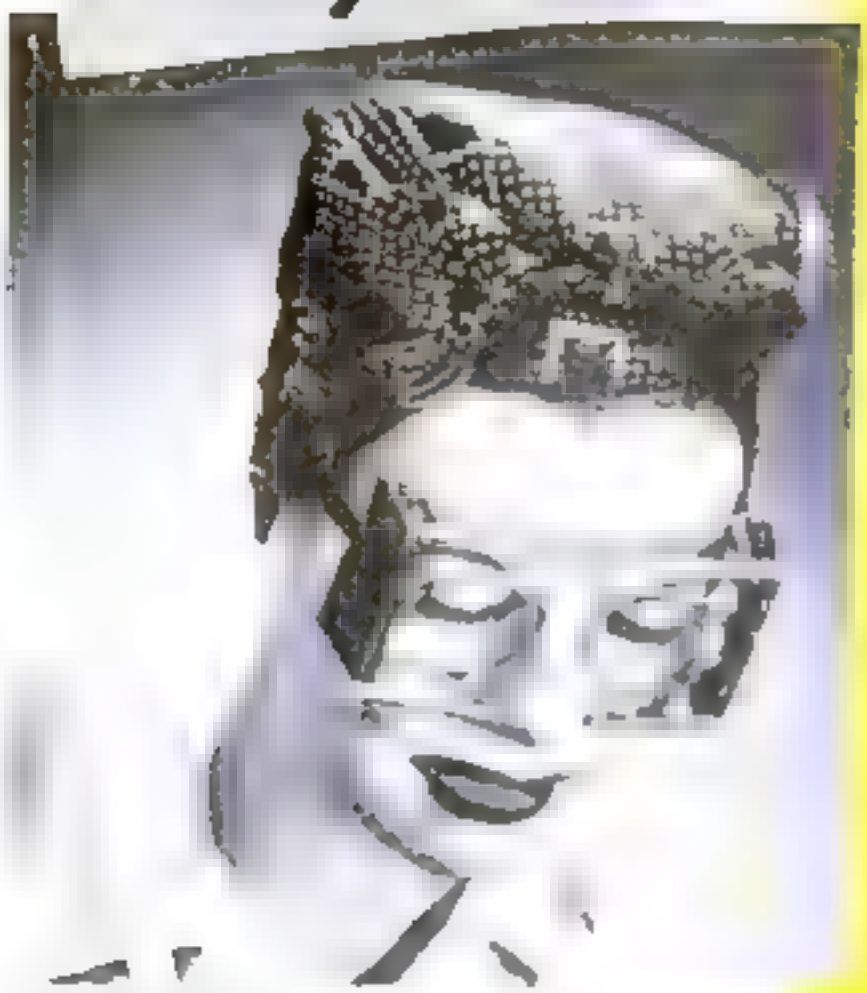


AIR evacuation of sick and wounded soldiers is being hailed as a great saver of lives in this war. Big cargo planes, flying matériel into battle zones, are converted into swift aerial ambulances for the trip back.

In New Guinea, where transfer over mountains would take three weeks, planes cut the time to less than one hour. A critically injured soldier was brought from Indo-China to the United States in eight days, Brig. Gen. David N. W. Grant, Air Surgeon, reported recently. By land and sea, the trip might have taken three months.

NOVEMBER, 1943

new Tools



ALL-PLASTIC GOGGLES, set with shatterproof Plexiglas lenses that insure clear and undistorted vision, are now manufactured for war workers by the Watchemoket Optical Co., of Providence, R. I. Weighing less than two ounces, the full-framed goggles fit right over prescription glasses. Perforations in the frame prevent fogging, and special filters can be snapped on the lenses for glare protection

A CLEANING CAGE that makes short work of small parts like gauges and bearings has been designed by the L. & R. Mfg. Co., Newark, N. J. Run by electricity, the unit is as simple to use as a washing machine and is easily operated by a woman. The speed of the whirling cage, which holds the dirty parts, can be adjusted for varying needs. Entire portable unit weighs less than 50 pounds

ONE-MAN RIVETING with a vibrator that is controlled by the "travel" of the driving set has just been perfected by the Buffalo Airplane Division of Curtiss-Wright. This "jam riveting" can be done with either a hand or standing vibrator, and is especially valuable on tricky jobs like cowling manufacture. Since the gun is internally controlled the work is unusually accurate

ELECTRODE HOLDERS slim enough to work in tight places and weighing only 12 ounces are offered by Jackson Products, of Detroit. Insulated, the holder guards welders' eyes from flash and cuts out waste due to touching work with bare holders. It holds rods up to 3/16 inch

Brain-Teasers in Uniform

SEVEN PROBLEMS WITH A WARTIME SLANT

1. His Dollars Make Sense

A MAN puts half his week's pay into war bonds and stamps. After buying them, he has left just as many cents as he had dollars, and half as many dollars as there were cents in the envelope when he received it. What is his weekly pay?

2. Bombing by Halves

A BOMBARDIER is told to set fire to four enemy towns. Over the first one he drops half his bombs and half a bomb. Over the second he drops half the bombs he has left plus half a bomb. Over the third town he drops half the remaining bombs and half a bomb. Then, taking count, he finds that he has 36 bombs left for the fourth town. What was his original load?

3. Defense Without Design

A FIELD of pillboxes is laid out as illustrated here. Corporal Fussbudget, gunner, whose secret passion is design, is considerably upset by the fact that his pillbox, M, plays no essential part in the design created by the other boxes. How might the Army engineers have laid out the field to put all 13 into a similar pattern, and so satisfy the corporal's aesthetic sense?

4. Ships That Pass in the Jungle

BOATS A, B, and C, carrying men up a narrow jungle river, meet boats D, E, and F, bringing down wounded. There is no room to pass, but there is a small basin at P which will admit any one of the boats singly. How can the boats pass?

5. It's Later Than They Think

A CERTAIN street corner in an occupied coastal city is guarded day and night by German sentries. The watch is changed every time the two hands of the clock coincide. At what times, within 24 hours, will the guard be changed? If no guard is on duty there more than once each week, how many will serve on that corner from a minute before Monday noon to a minute after Sunday noon?

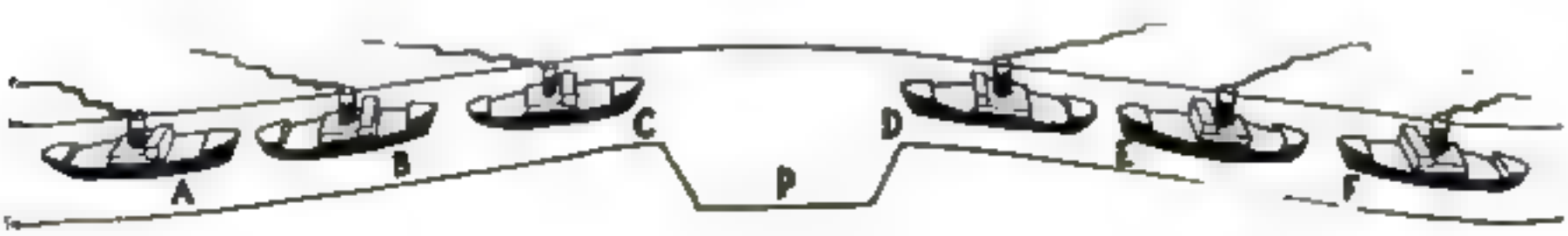
6. Japs with a Price on Their Heads

SUPPOSE Army Intelligence offers a bounty on Jap prisoners brought in for questioning. Outfit A brings in half a dozen dozen Japs and is paid a dozen dollars the half dozen. Outfit B brings in a dozen dozen Japs and receives half a dozen dollars the dozen. Which outfit receives more money?

7. Getting in Under the Wire

IMAGINE, if you can, a row of telephone poles set up to girdle the earth at the equator. Suppose also the earth is a perfect and even-surfaced sphere of exactly 25,000 miles circumference. Now string on the poles a high-voltage wire 100 feet longer than the circumference of the earth, so that when the current is thrown on there is a charged circle around the earth concentric with the equator. Could a man pass under this wire at the equator without touching it? Could a ship pass under it?—E. J. DINTRUFF.

See page 220 for answers.



How You Can See the Weather

Great currents in the atmosphere produce the changes that make us call it a "nice day"—or swear!

By DON ROMERO

Drawings by ERIC SLOANE

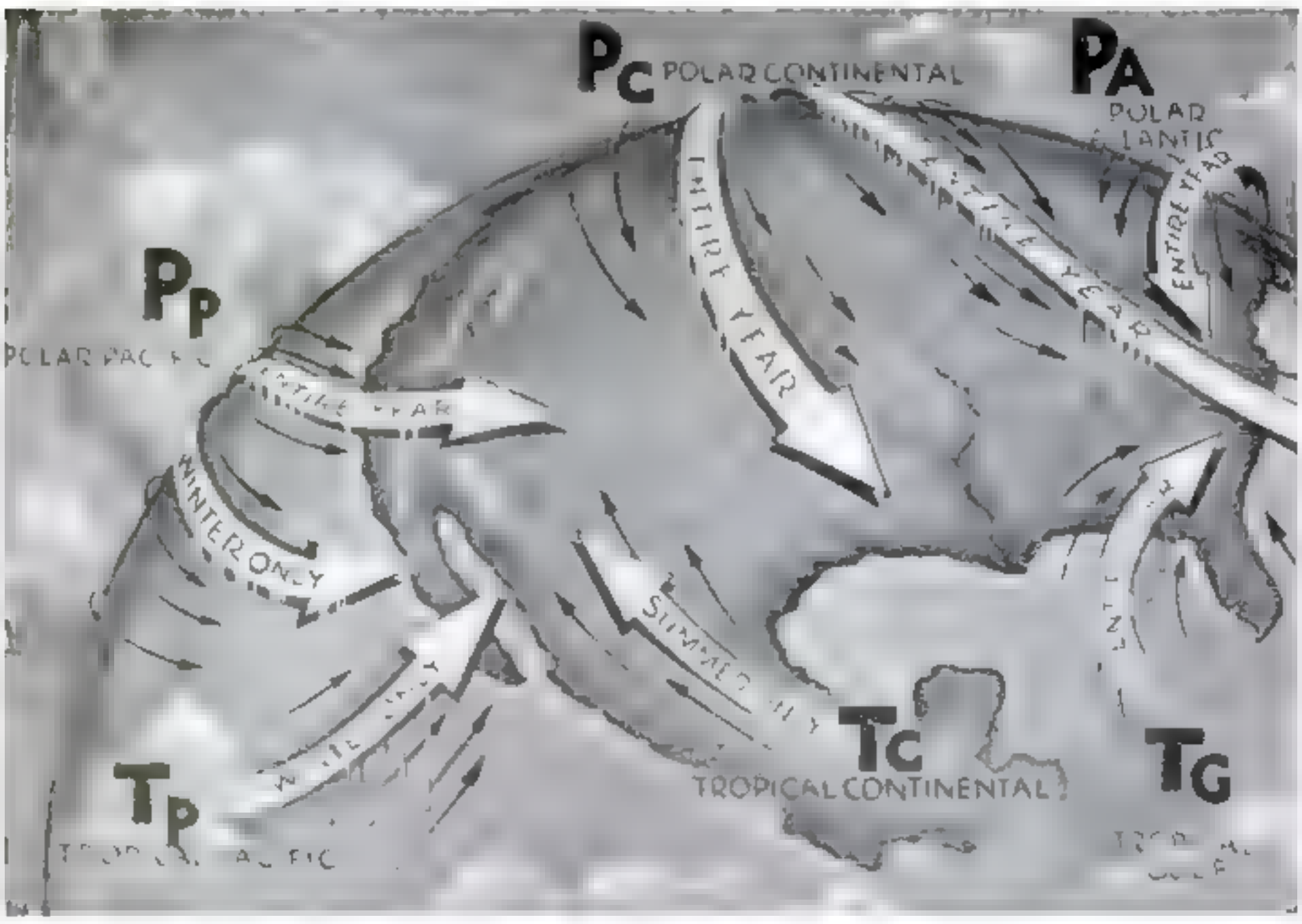
WHEN Mark Twain said that everybody talks about the weather but nobody does anything about it he did not envision the spectacular advances that lay ahead in meteorology. Nor did he foresee the day when the airplane would be as common as the horse and buggy and when, to every pilot who took his plane into the air, the weather, instead of being a subject of casual conversation, would be a matter of life and death.

Up to now, most of us have looked upon weather forecasting as pretty much a hit-and-miss affair. Meteorologists talked solemnly of rising pressures and departing storm centers, but few of us had faith in the prediction that tomorrow would be "fair and warmer." Often we were just as ready to listen to some old-timer who, with an eye for the weather, would cast a knowing glance at the sky and then recite some ancient jingle such as "Mackerel sky, not three days dry."

Today, however, meteorology largely through the medium of aviation—is bringing home to many of us a new and entirely

WHERE AMERICA GETS ITS WEATHER

Governing the weather of the United States are a number of huge bodies of air, each of which takes its name from the region from which it comes and where it has matured. Sweeping across the country in the directions indicated on the drawing below, these major air masses determine almost entirely the weather of the areas over which they pass. In turn, however, they are often affected



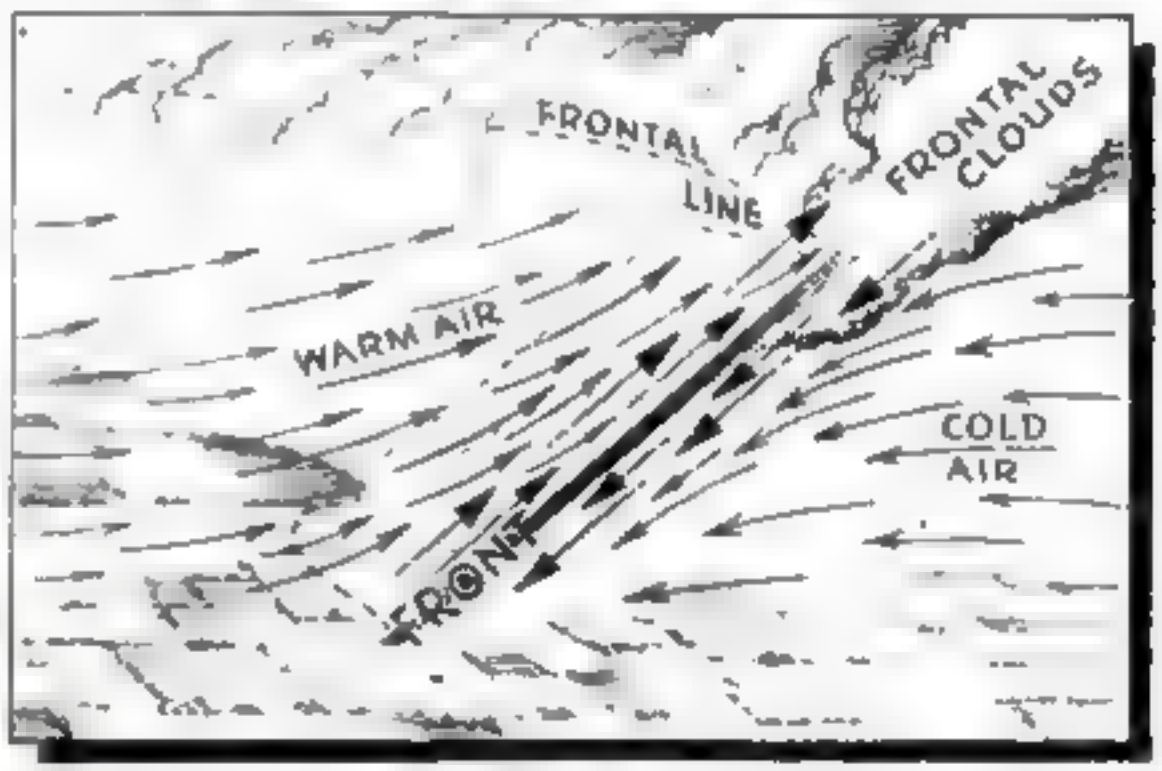
understandable concept of the enormous mass of air that floats over our heads. It is taking that gigantic ocean and showing us not only how to "see" it, but also how to feel it and smell it!

Known as Air Mass Analysis, this new concept is based on the studies and experiment of Vilhelm Bjerknes, who, with other Norwegian meteorologists, was one of the pioneers in the science of "long-distance" weather forecasting. Instead of visualizing the atmosphere as one vast sea whose vagaries accounted for weather that could be predicted with certainty only a few hours in advance, Bjerknes discovered that the atmosphere actually is composed of several giant individual bodies of air, each of which is distinguished by its own heat, humidity, and clarity. Bjerknes also discovered that, at definite times of the year, these bodies of air moved in well-defined paths across the earth's surface. He also found that the weather that prevailed in a given area was governed almost entirely by the type of air that was occupying that area at that time.

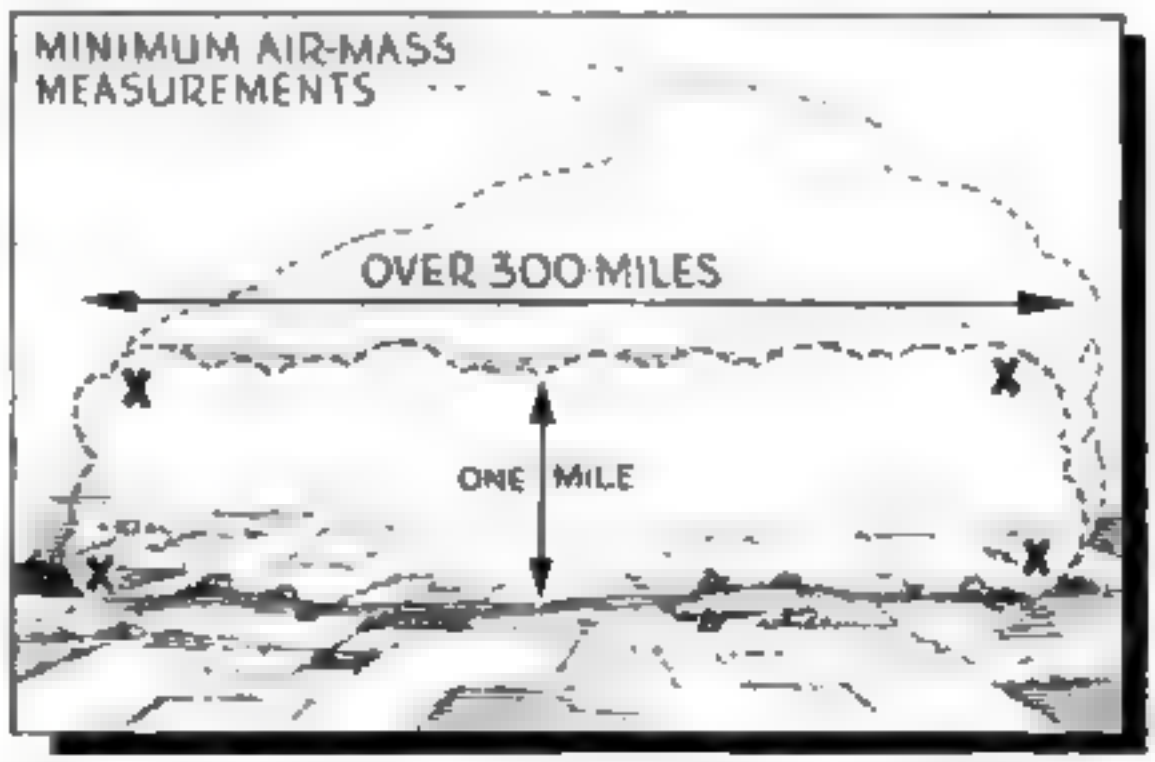
Known by the outlying regions from which they come and where they have been conditioned, several of these huge air masses dominate the weather of the United States. The Tropical Atlantic and Gulf airs are warm, humid currents that have been cooked up by the intense sun and warm sea water of the Caribbean region. The Polar Atlantic is a cold, low-clouded, drizzling current that sweeps down from the Grand Banks off Newfoundland. The Polar Continental is a cold and lively current of air. From the deserts of Mexico and Arizona comes the Tropical Continental—a burning, arid body of air that fortunately gets only as far as Oklahoma, Colorado, and Kansas. Up through Southern California comes the Tropical

by the temperature, humidity, and topography of the ground. Changes in the weather come as a result of one air mass invading an area occupied by another

AIR MASSES AND THEIR "FRONTS"



"Fronts" are set up when two air masses of different types come in contact with each other. It is here greatest turbulence occurs



Here a mass is shown moving over a ground area. As long as it remains unaffected by the contact, the mass will have the same specific humidity and potential temperature at all "X" points

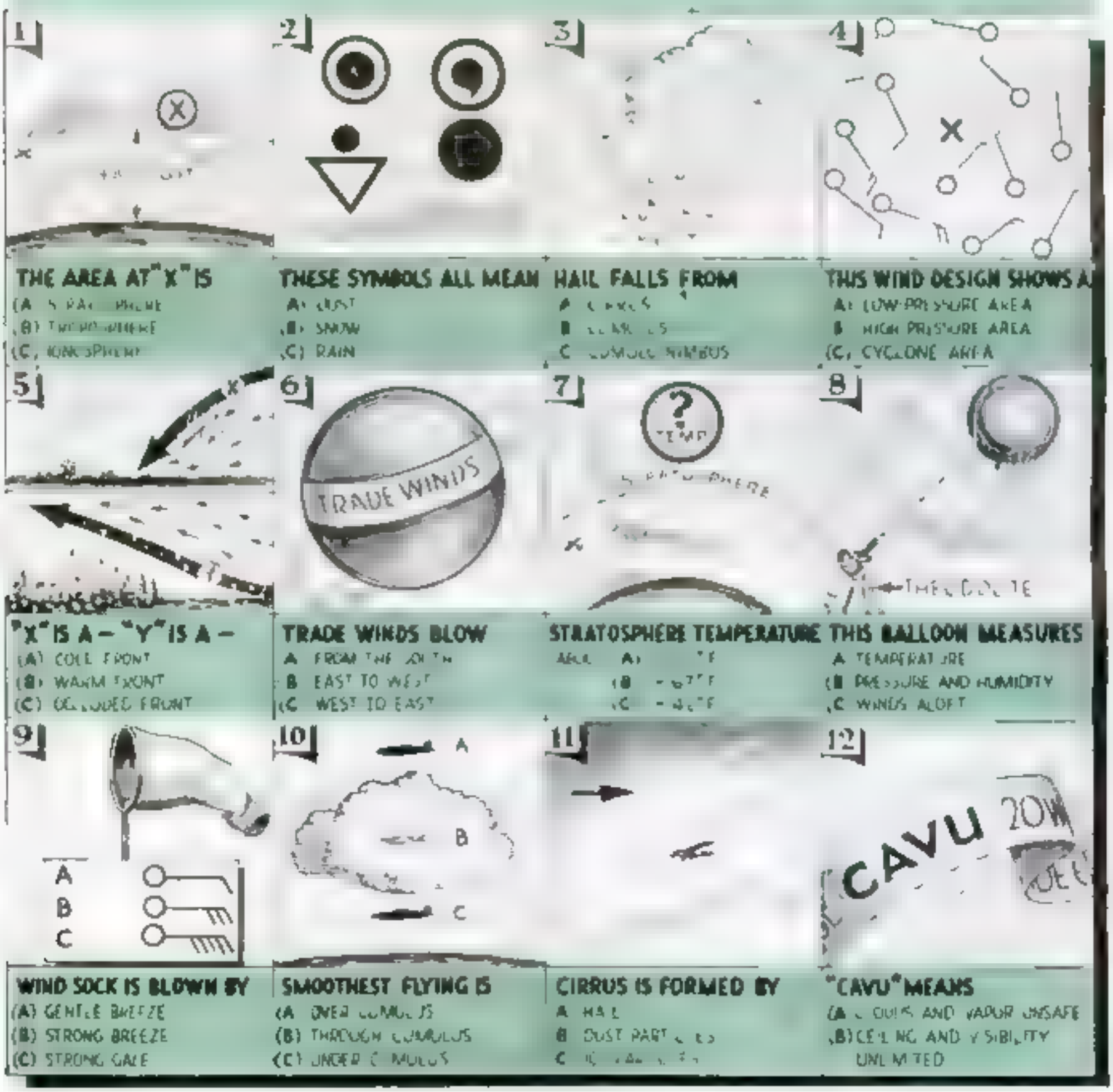
Pacific, a soft, lazy kind of air that is believed to originate in the South Seas. The cool, moist Polar Pacific that chills Seattle comes all the way from Siberia. The eighth body of air—Sec Superieur—is believed to originate in the stratosphere over the Galapagos Islands.

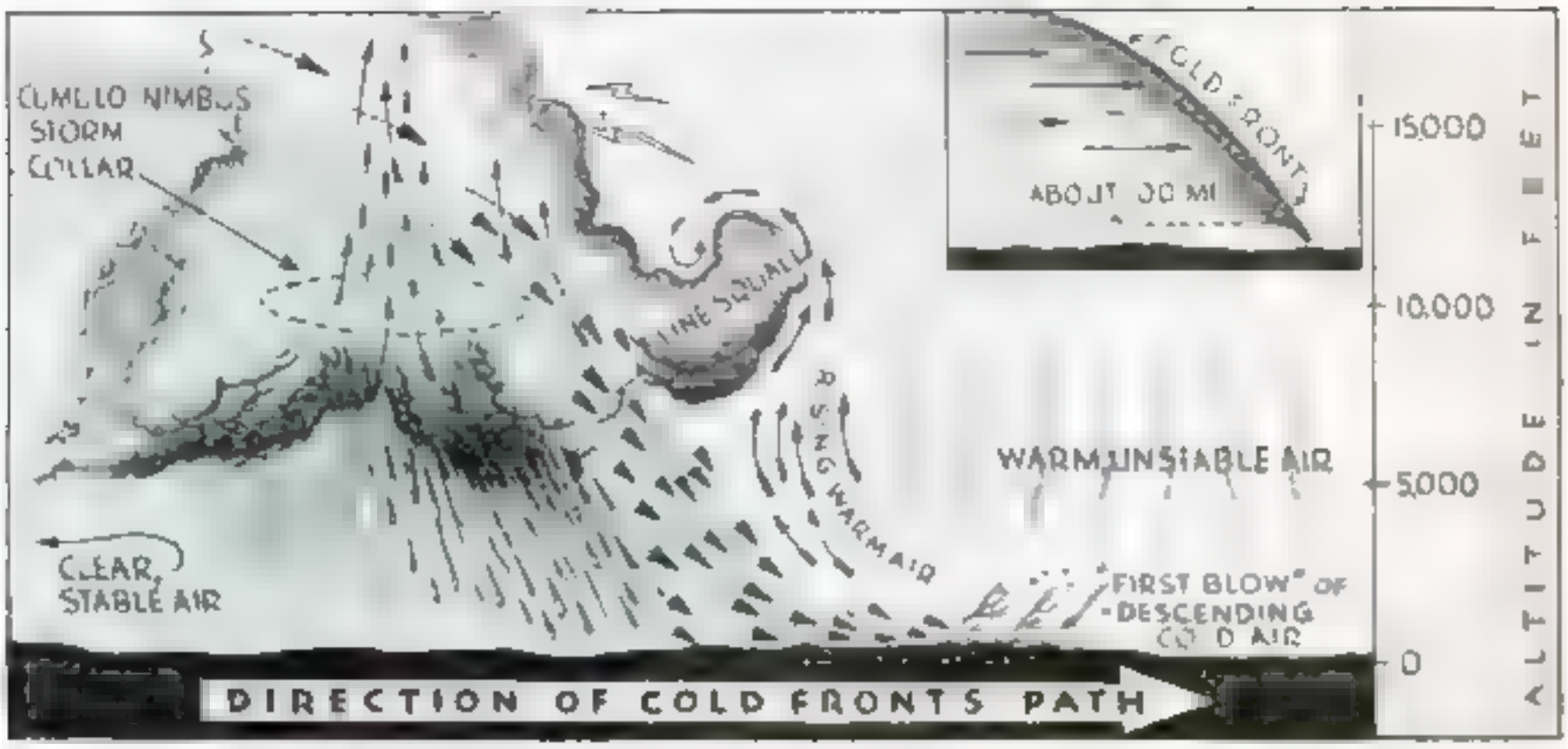
One thing that must be kept in mind is that while these bodies of air largely determine the weather, they, in turn, are often affected by the areas over which they pass. An air sweeping down over a lake region is very likely to bring weather that is raw as well as cold. A warm, moist body of air moving over cold ground will be responsible for cloudy weather—caused by the air's lower layer being chilled and thus having some of its moisture condensed into visible form. A clear, cold body of air passing over a hot area will pick up little heat from the sun, but will allow its rays to continue to heat the earth's surface, and then absorb heat from that.

Even the topography of the ground can, for a time, change the character of an air mass. Coming in at a low level, a warm current can be carried up the side of a high mountain range and be tossed high into the air—with a resulting condensation of its moisture that may keep the mountain range

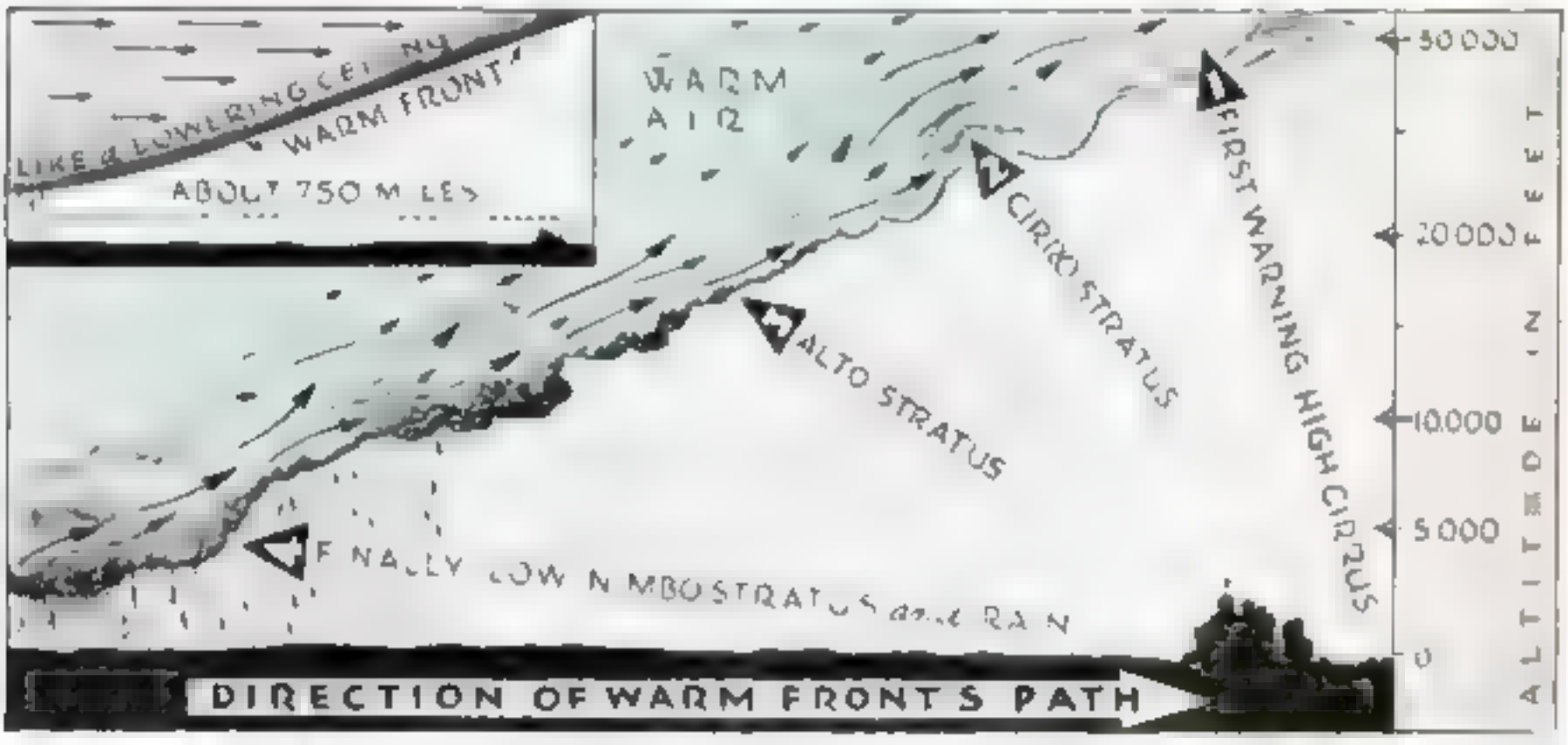
What Do You Know About Weather?

This not-too-difficult quiz will help you to test your knowledge of meteorology. Under each question are some possible answers, only one of which is correct. Check your answers with those on page 94





Being heavy, the invading cold air will tend to come in low, lifting the warm air as it pushes it back. In the northwest will appear a solid cloud bank—the actual "front"—which will build up as it advances



Invading warm air, being light, will come in "over the top." First warning will be "mares' tails," followed by progressively lower clouds, and rain. An invading cold air will then start the cycle all over again

snow-capped through an entire hot summer. Crossing the mountain peaks and rolling down the other side, this same air mass will be heated up again by the increased atmospheric pressure, and in its now drier state will be so thirsty for moisture that it will suck the surrounding sky dry of every cloud.

Picking up heat from its contact with a warm area, the lower layer of a cool air mass will become light and will start to rush upward in the form of giant air bubbles, some of them hundreds of feet in diameter. A plane, flying along in cool, stable air, will get a sudden jolt as it is caught up in one of these swiftly rising currents, and then will be dropped with equal suddenness as it escapes from the bubble area. Although pilots of passenger planes naturally strive to avoid such turbulent spots, they can be of help to a pilot who has to gain altitude quickly. All he needs to do is to keep circling in one of these bubble areas and let it shoot him skyward at a much faster rate than he could climb. The same is true—and of greater importance—to the glider pilot, who must rely solely on upward currents of air to stay aloft.

As important as the discovery of the air masses themselves is the locating of their "fronts"—the border lines that separate one mass from another. Modern meteorology is teaching us to "see" these invisible masses by observing the action that results when one mass drives out another, for it is at

these fronts that "cloud" banners most clearly define the otherwise invisible air currents. The greatest local disturbances are associated with these fronts.

One of the ingenious methods by which schools of meteorology are teaching students to "see" individual air masses involves the use of warm water that has been colored red, and cold water that has been colored blue. When poured into a glass and viewed from the side, these two types of water can be seen to set up the same kind of "fronts" that occur in the atmosphere: the cold, heavy water tending to push downward; the warm, light water surging upward.

"Feeling" and "smelling" the weather, long considered whimsical notions of forecasting, have also been reinterpreted for us in a practical and understandable way. "Smelling rain in the air," for instance, means that we are in a low-pressure, or storm, area; odors from swamps or other low, moist places, formerly held captive by the high pressure of good-weather air, have now been released into the atmosphere. When we say that "it feels like rain," it merely means that we are reacting to a falling pressure, which has a definite physiological effect on us, such as making us depressed or irritable. Other similar storm signals are the game leg that starts to pain, and the corn that begins to ache.

Almost simultaneously with the discovery of "long-distance" weather forecasting came the realization that here was a powerful weapon of war. Soon after the Norwegian pioneers announced their findings to the world, the Germans started an intensive study of modern meteorology. Following close on their heels came the Japs, who today have a first-rate weather bureau.

How well the Germans have learned the new science is evidenced by the spectacular escape of their battleships *Scharnhorst* and *Gneisenau* through the English Channel under the very noses of Britain's land-based bombers. At the time, it seemed as if the Germans had taken a 100-to-1 chance, and won. Actually, with characteristic Teutonic thoroughness they had timed the escape to the day—a day which their meteorologists long in advance had advised the Admiralty would bring the worst weather that the Channel had seen in years. Even if the

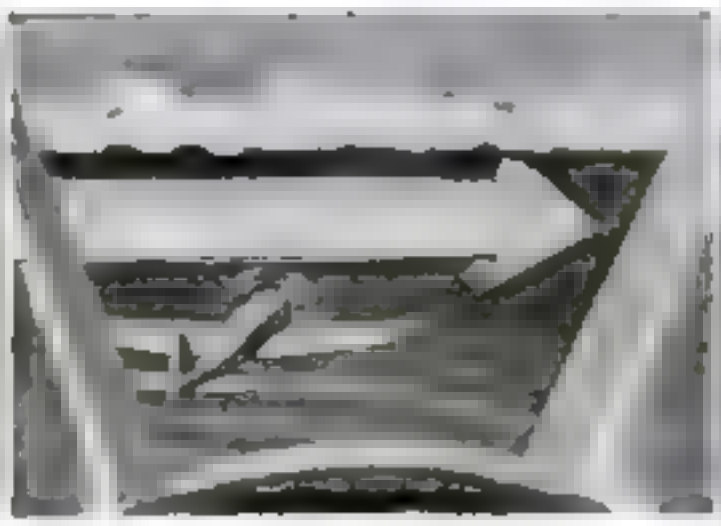
ANSWERS TO QUIZ ON PAGE 92

1—A	5—A, B	9—A
2—C	6—B	10—A
3—C	7—B	11—C
4—B	8—C	12—A

MOTION PICTURES TEACH PILOTS HOW TO

These drawings are from one of a series of aerological

Carrier-based planes are sent on scouting mission that will take them through cold front on both outward and return flights



2 Cumulus clouds appear on northwest horizon, and extend far to left and right. Plane drift is northward, indicating southerly winds. Air is unstable

3 Section leader now knows that he is approaching the cold front. Low cloud bases and a dark, unbroken rain area indicate a storm

On return trip, flight is at a low level, for cloud bases have lifted and clear spaces are to be found in heavy rain area

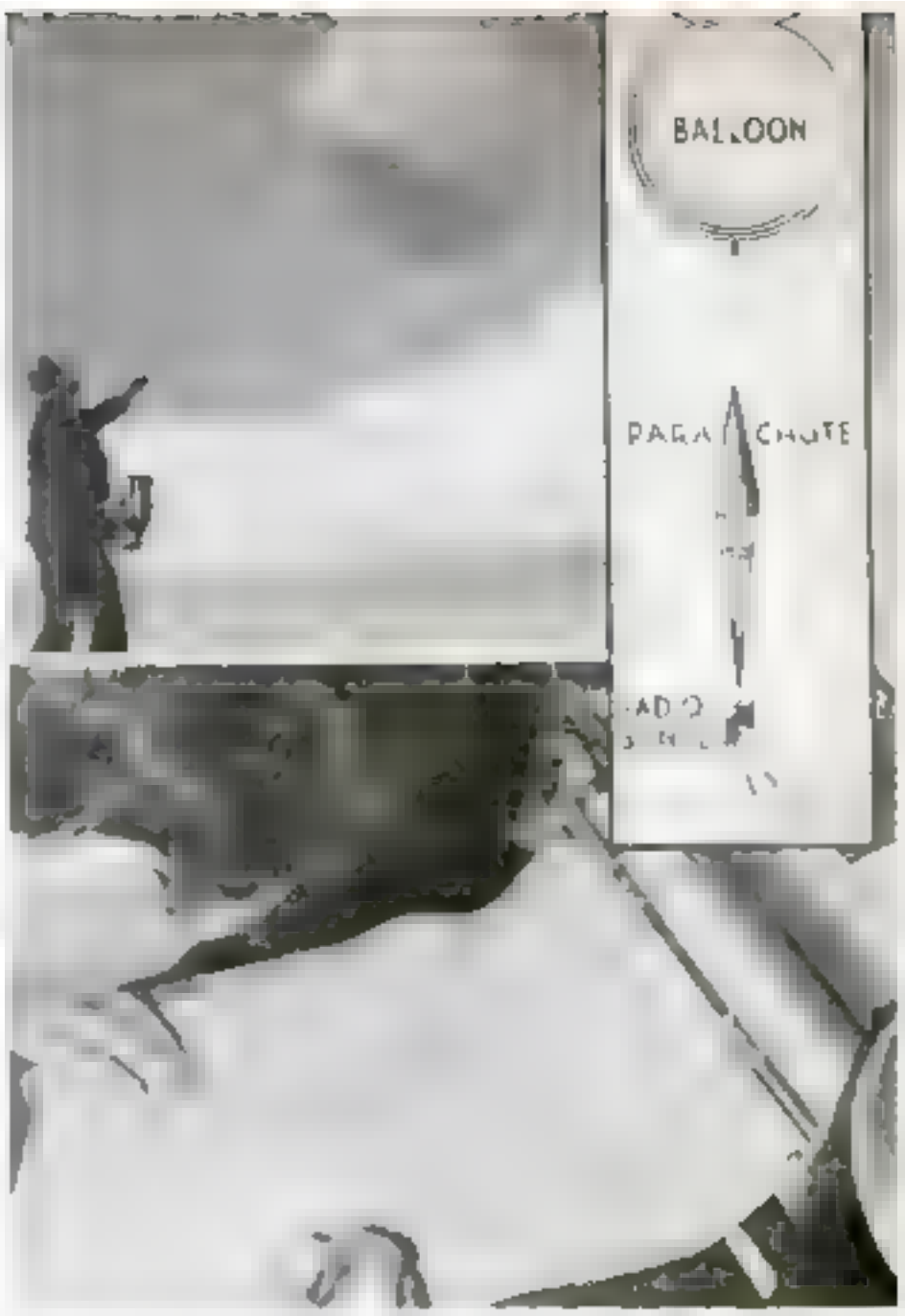
8 Selecting a light area, the leader goes into the front at right angle. To avoid the storm, he flies as close to the ocean surface as safety permits

9 Close on the tail of their leader, the other planes wing their way into the "hole" he has found. The direction of the wind is now northerly

British bombers had known that the ships were in the Channel, they would have been helpless, for a "pea-soup" fog enveloped the vessels as they raced for the open sea.

When Germany launched its invasion of Poland, the Poles, fighting fiercely to resist an already overpowering foe, cursed the luck of the invaders in the excellent weather that was aiding their advance. Actually, the Germans had waited for months for the weather to become their ally, and had not dared turn a wheel before their experts had guaranteed them two absolutely dry and clear weeks in which to move their tanks and trucks.

Most Americans like to believe that the Japs chose December 7 for their attack on Pearl Harbor because it was a Sunday, when normally the base would be enjoying "a day off." More likely the truth is that they carefully selected a time when it would be good sailing weather for their carriers, good flying weather for their planes, and a clear day for bombing an unsuspecting foe. In one notable instance, however, Jap meteorologists badly misread the signs. In the Bismarck Sea engagement, the Jap armada was advancing under the protective screen of a thunderhead when suddenly the clouds evaporated into a clear sky and left their battleships and transports sitting like ducks on a calm lake. (Continued on page 220)



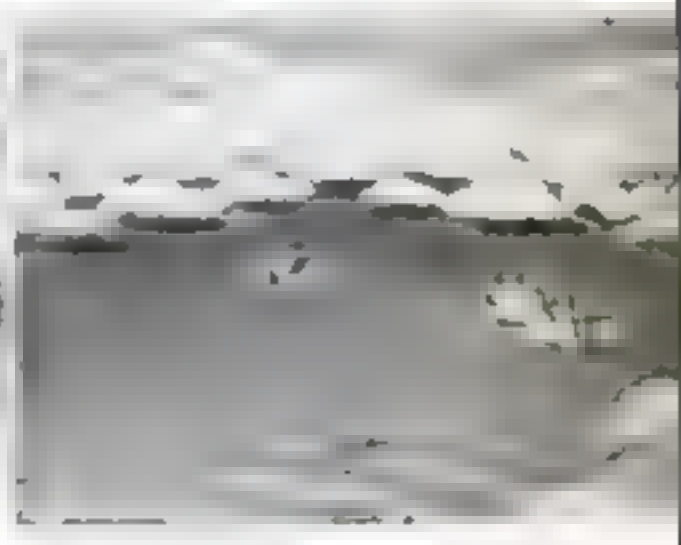
RADIOSONDE An invaluable weather device, this robot broadcaster sends down to earth a steady stream of atmospheric data as it ascends at the tail of a balloon. In the stratosphere, the balloon bursts, and the radiosonde floats to earth supported by a parachute

AVOID THE DANGERS OF A "COLD FRONT"

training films made by Walt Disney for the U. S. Navy

4 Leader avoids storm by climbing. When temperature of outside air drops, he makes drift correction to right to make up for change in wind

5 Once the flight section is past the storm line, the leader takes it down until the surface of the water can be seen through the clouds

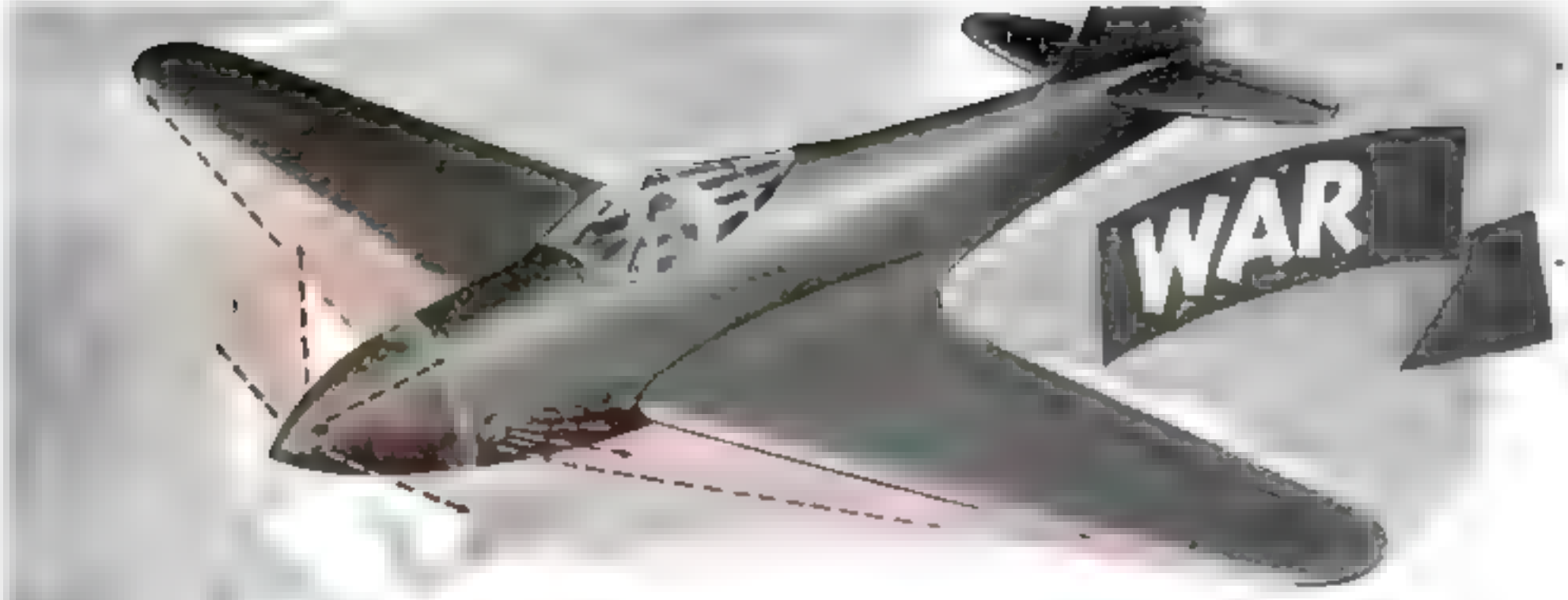


6 At this point the planes descend to scouting level and proceed on their assignment of searching the designated area

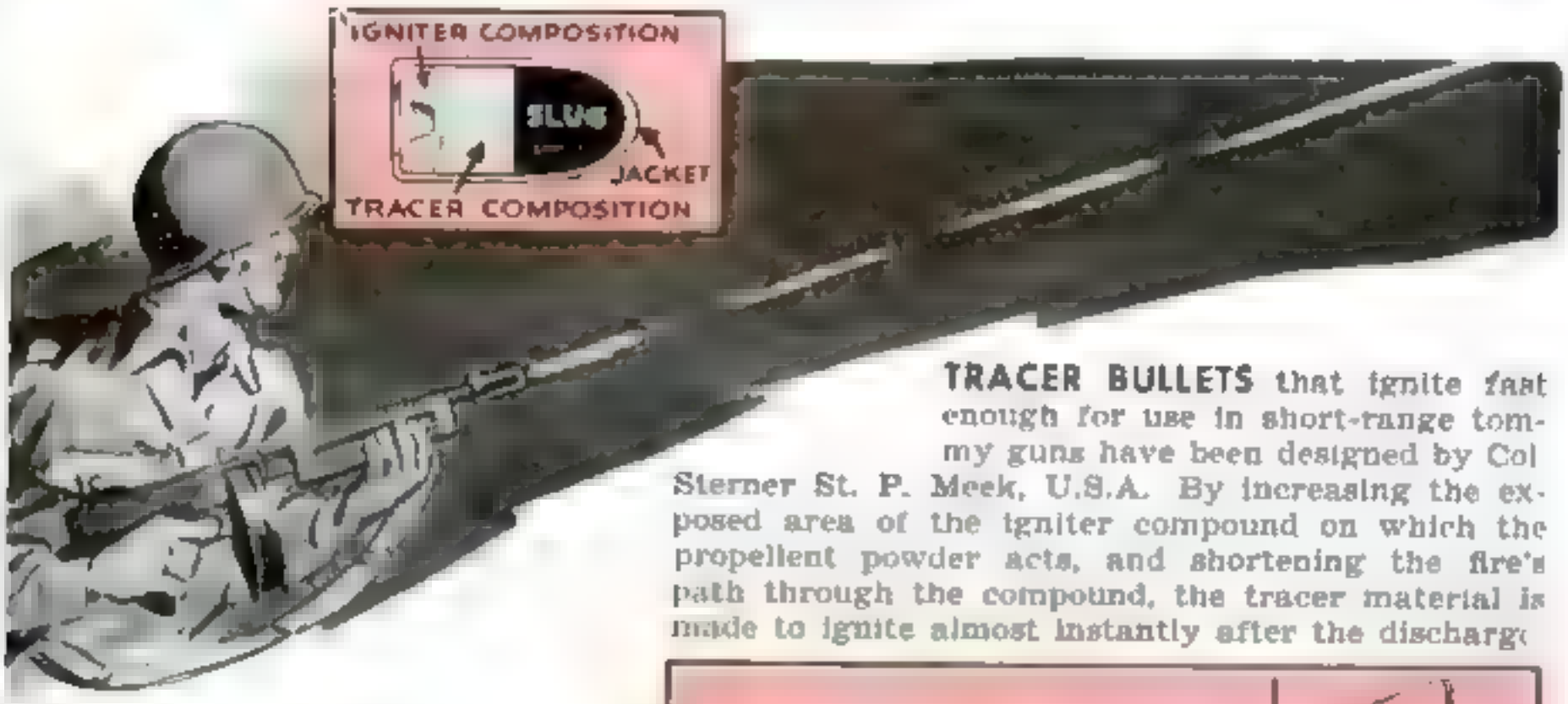
10 In a few minutes the air temperature begins to rise, indicating that the planes are through the front and in southerly winds

11 In another minute or two, all of the planes have popped out the other end of the "hole," and in front of them is nothing but clear sailing

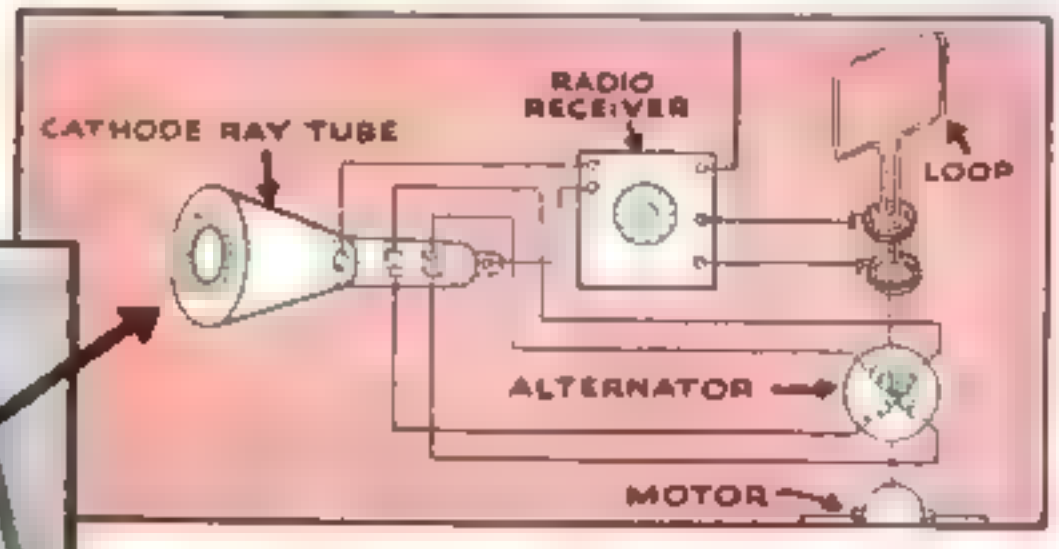
12 Accomplished with apparent ease, this mission could have cost lives if leader had not shown good weather sense



INFRARED DE-ICING RADIATORS are proposed by J. D. Altemus, of Roslyn, N Y., as a new solution to one of aviation's most insistent problems. Mounted on the nose and propeller hub, the radiators would focus their beams on the propeller blades and leading edges of the wings to keep them above icing temperature.



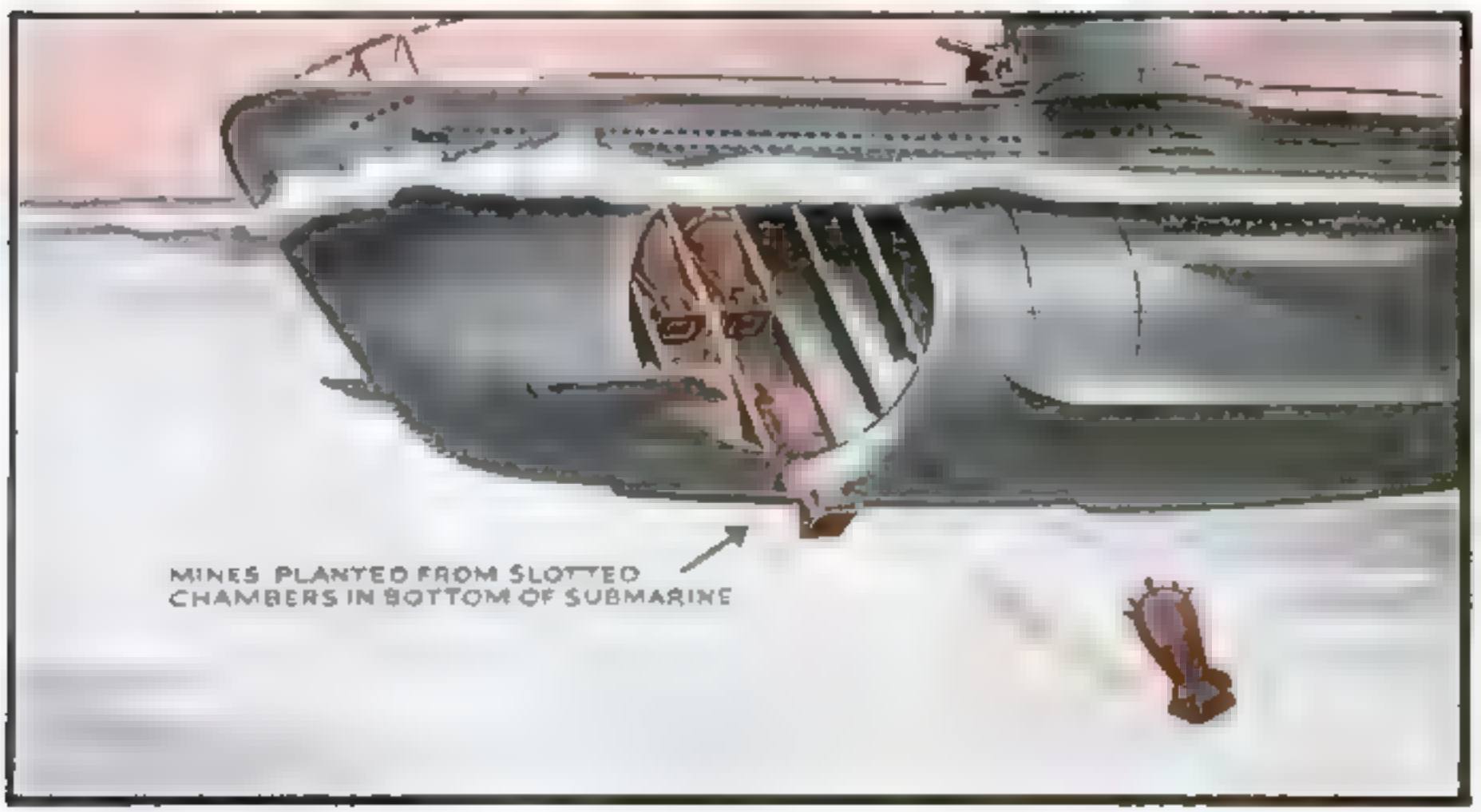
TRACER BULLETS that ignite fast enough for use in short-range tommy guns have been designed by Col Sterner St. P. Meek, U.S.A. By increasing the exposed area of the igniter compound on which the propellent powder acts, and shortening the fire's path through the compound, the tracer material is made to ignite almost instantly after the discharge



A NEW DIRECTION FINDER employing a cathode-ray oscilloscope has been developed for planes by Donald G. Little, of Baltimore As the loop antenna revolves, a circular wave pattern appears on the oscilloscope screen which is calibrated to 360 degrees. When radio signals begin to come in, a depression appears in the pattern to indicate the direction from which they are being sent

FLAME-THROWING TANKS that are said to be able to spew out their jets of fire a distance of 110 yards are reported to be among Germany's new "secret weapons." The tanks are also said to be equipped with a smoke-screening device that makes it possible for them to envelop themselves in a thick artificial fog in a matter of a few seconds.

MINE-LAYING U-BOATS are now believed to be in use by the Germans in an effort to destroy the bridge of ships carrying supplies to our allies and overseas forces. In addition to torpedoes, the U-boats carry a substantial load of mines which they can plant while submerged by dropping them from slotted chambers.



Fighting on a thousand fronts is "Ghost Light" OUR NEW WEAPON IN THE DARK

By JEAN ACKERMANN

A LEADER of a night scouting party consults his map. As he is near the enemy lines, it would be suicide to strike a match or use a flashlight. No need. Printed in luminous ink, lines of the map shine dimly but clearly in the dark.

The party moves on. Lest his men become separated from him, the leader wears a faintly glowing button on his back. Similarly, to the rear, ghostly processions of blacked-out tanks and troop-loaded trucks are advancing in follow-the-leader style, each guided by a spot of luminous paint on the one ahead.

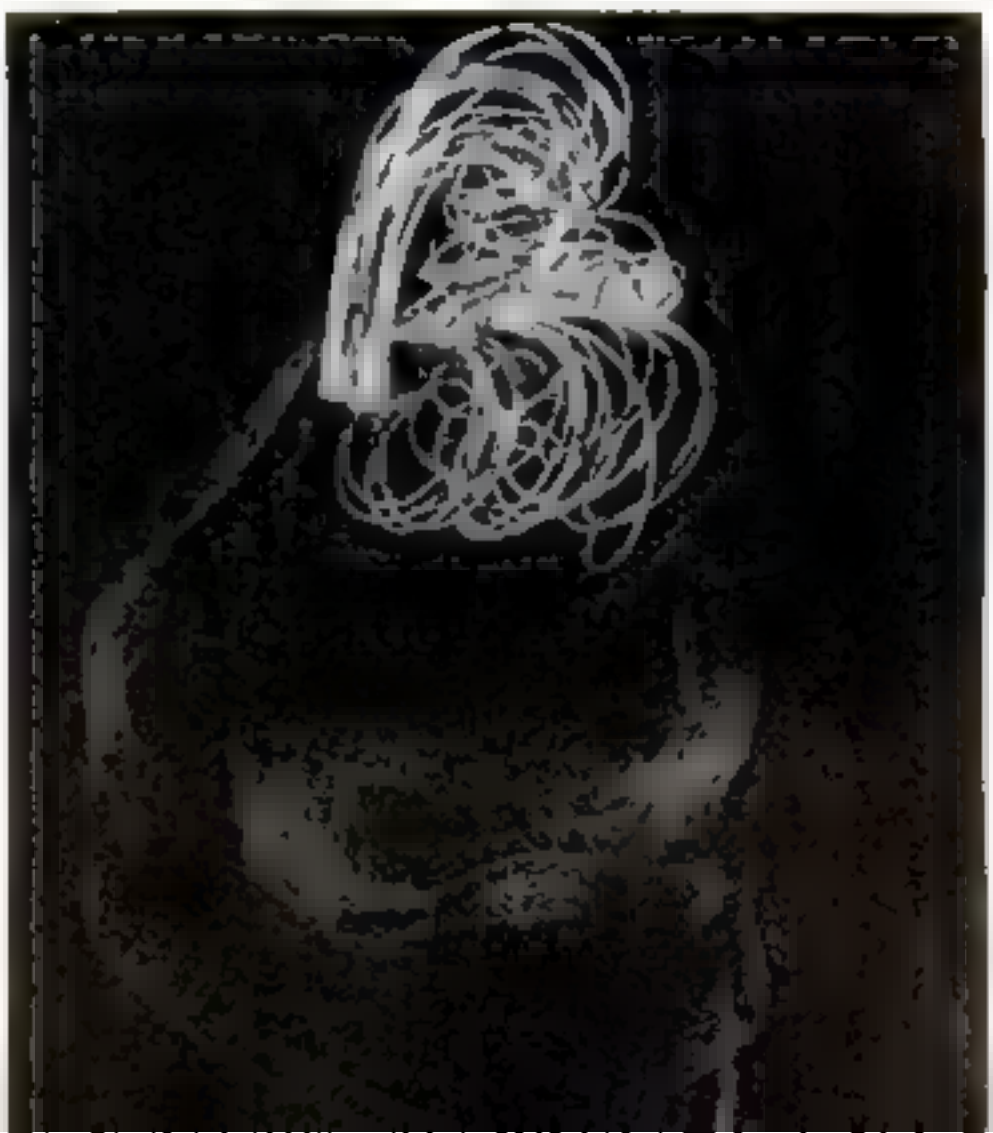
Now the scouts have completed their mission. To mark directions for the secret troop movement, they have daubed roads and trees with splotches of ordinary-looking paint. When a soldier turns the invisible beam of a special black-light flashlamp upon one of the painted direction markers, it lights up as plainly as a traffic signal.

Through 30 centuries, from the time when ancient Egyptians used light-emitting minerals to create a mysterious glow around temple altars, the phenomenon called luminescence remained no more than a showy novelty. It turned up in the theater, where seemingly unoccupied shoes tapped brightly across an unlit stage, and where costumes and scenery gave striking luminous effects. It came down to earth, and into everyday life, in fluorescent lamps for homes, offices, factories, and outdoor displays. From this beginning, its practical uses on war and home fronts are multiplying constantly.

According to a recent order, all ships of more than 3,000 tons using New York Harbor must have doors, stairways, control valves, steam pipes, and other important points marked with luminous paint. Thus, in case a torpedo puts the regular lighting system out of commission, sailors can still make repairs or find their way to lifeboats. Direction markers pointing to air-raid shelters, and the shelters themselves, may use "firefly" illumination in total blackouts. Setting an example for motorists in air-raid

IVILIAN USE. Street curbs, doorknobs, stair-ays, light switches, and other similar points an be covered with luminous paint to guide eople safely through a blacked-out area

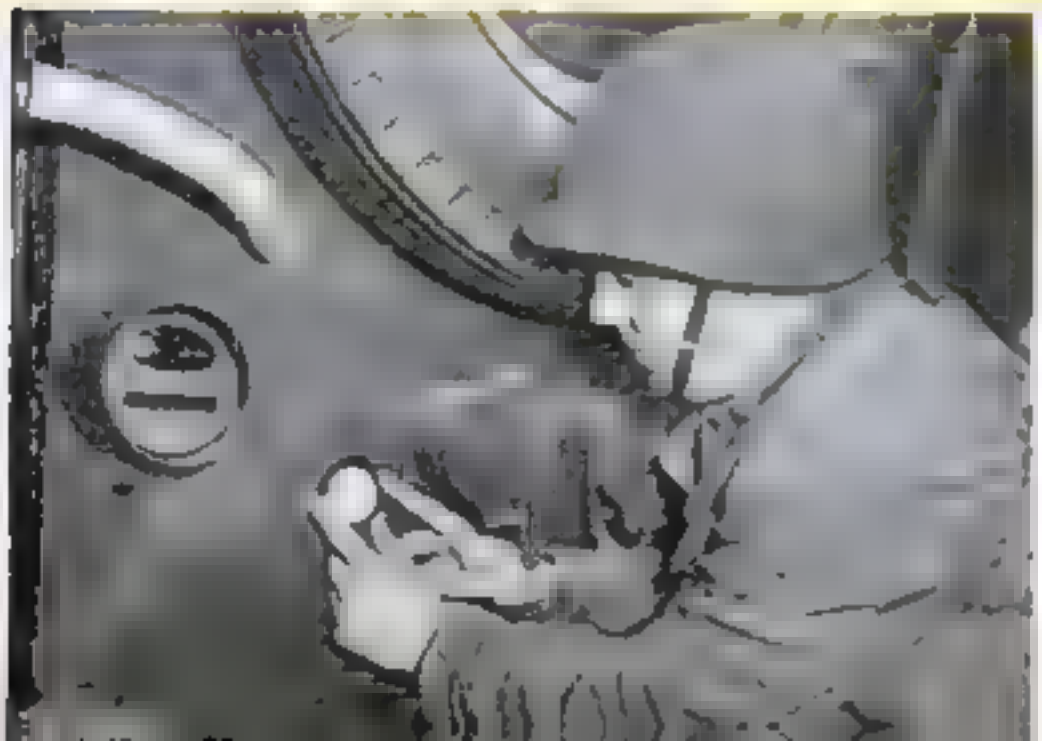
Fashion has not neglected to avail itself of the novel effects made possible by luminescence, using it on hats, dresses, capes, stockings, hairdress, and jewelry. In the theater, too, it often appears in settings and costumes

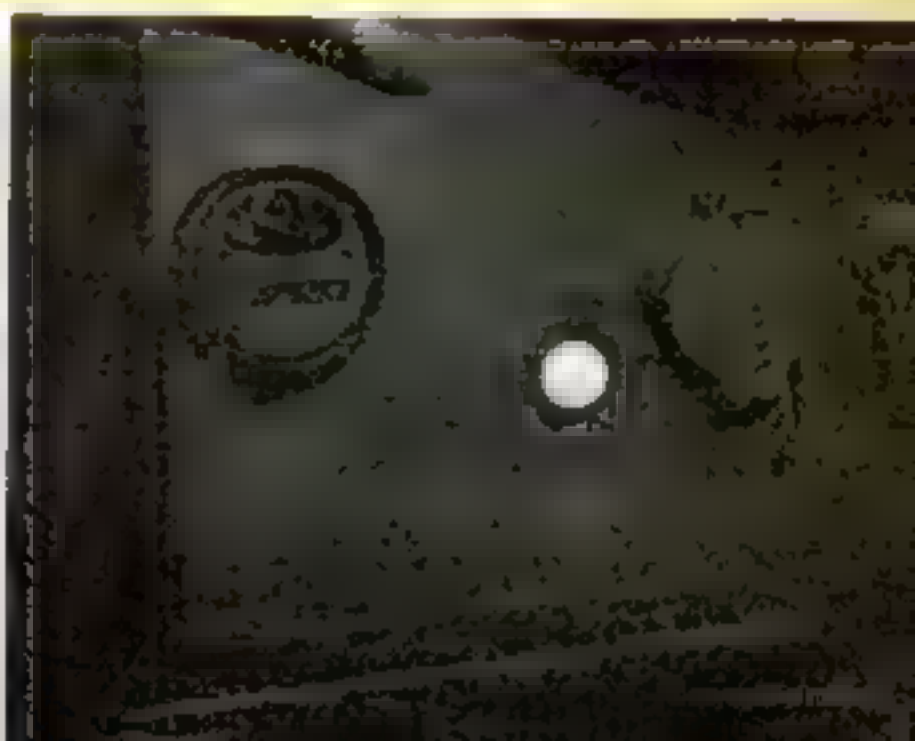


THREE KINDS OF LUMINESCENT MATERIALS

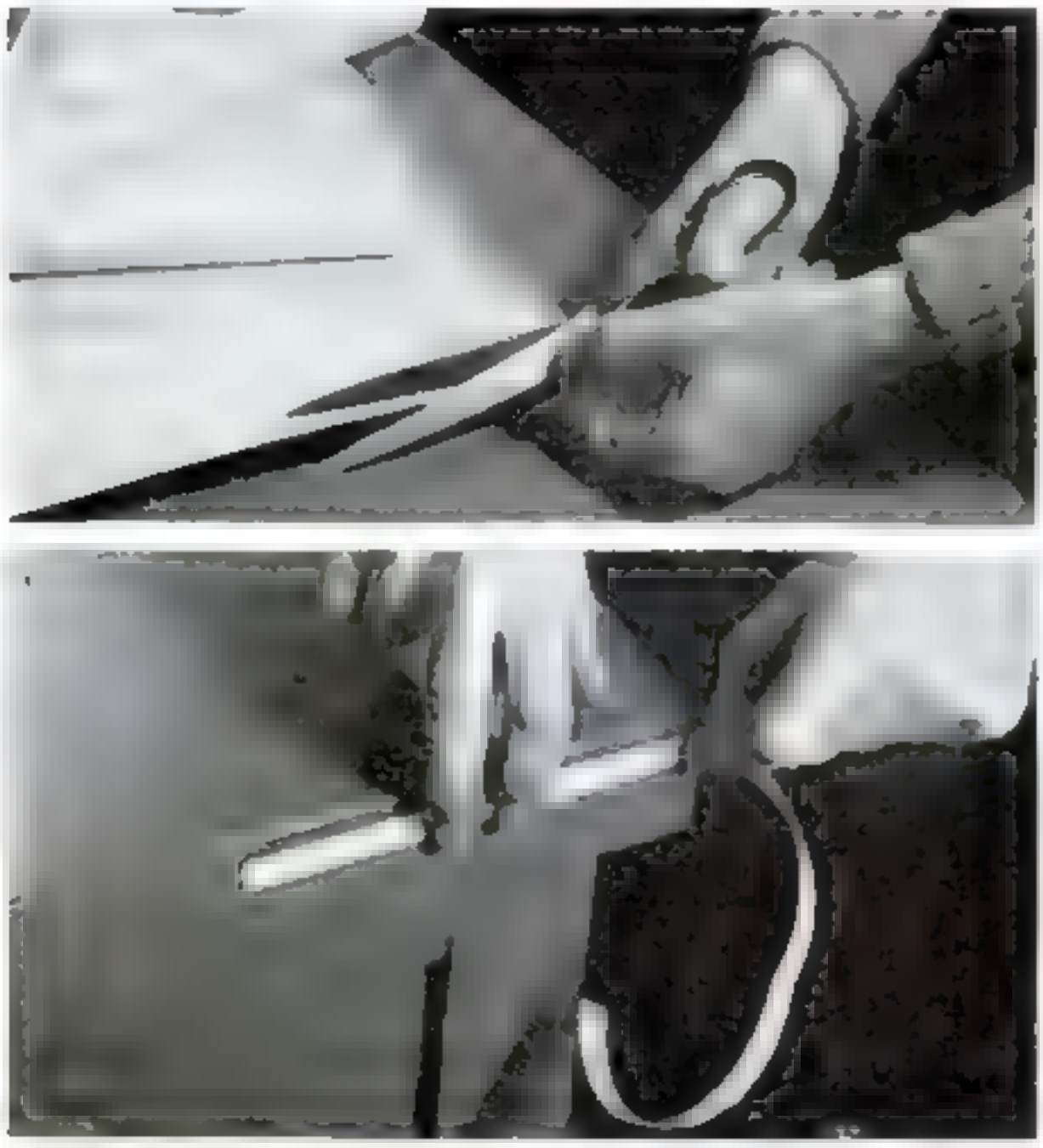
	FLUORESCENT GLOW DURING EXPOSURE TO ULTRAVIOLET RAYS	PHOSPHORESCENT GLOW AFTER EXPOSURE TO LIGHT OR ULTRAVIOLET RAYS	AUTOLUMINESCENT GLOW FROM SELF-CONTAINED SOURCE
NATURAL FORM	CALCITE WILLEMITE FLUORITE		
ARTIFICIAL FORM (POWDER, PLASTIC PAINT OR FABRIC)			
DURATION OF USEFUL BRILLIANCE			
WAR USES			
HOW IT WORKS			

MILITARY USE. A radioactive material sealed in a plastic case has been designed by army engineers to serve as a "tail light" for military vehicles moving through a darkened area. In a complete blackout the marker can be seen clearly at 100 feet. A similar marker worn by the leader of a night scouting party serves to keep the leader in constant view of his men and prevents the party from becoming separated





"LIGHTING" DANGER SPOTS IN THE HOME



In an air raid, more damage is likely to result from people bumping into things in the dark than from the bombs. Pasting luminous material on such dangerous spots as pointed desk corners helps to prevent accidents

precautions; New York's Mayor La Guardia uses a car with phosphorescent fenders and bumpers. Many London streets and sidewalks now are outlined with luminous strips or curb markers, which we may possibly adopt in coastal areas.

Fluorescent powders can be used for testing the soundness of a gas mask. They are spread on the outside of the mask, the wearer takes several breaths, and the interior then is examined under black light for telltale glow.

Cases of arson and other forms of sabotage committed with pilfered explosives have been cleared up by injecting traces of fluorescent dye into the waxed-paper wrappings of sticks of dynamite, and the gums and glues that go into bombs. It is impossible to handle them without getting traces of the dye into the pores of the skin. Suspects, rounded up and questioned in a routine way, are then suddenly exposed to black light. The dramatic evidence of glowing hands seldom fails to obtain confessions. Senders of false fire alarms, and passers of counterfeit money, have been trapped by somewhat similar means.

In a standard industrial test for flaws in castings and stampings, the piece is magnetized and dusted with metallic powder, which outlines any cracks or internal defects. A recent improvement on this scheme makes the powder luminous under black light, giving a more conspicuous and sensitive test. The method will also test a surface for freedom from oil.

Medical workers find a new tool in fluorescent stains. Cancerous and other cells treated with these dyes and examined under a microscope with black-light illumination reveal characteristics that can be observed in no other way.

For "blackout parties," originated in raid-darkened London, luminous clothes and furniture provide the only light in the house — except in such games as "blackout golf," played with a self-glowing club, ball, and indoor putting green. Fashion fads include luminous dresses, capes, hats, stockings, hairdress, and jewelry.

More practical domestic uses of modern luminous paint will reduce our yearly toll of 30,000 fatal home accidents. Danger spots such as stair treads and electric fans glow all night when outlined with long-wearing phosphorescent preparations. Applied to street numbers, doorknobs, keyholes, and light switches, they serve a home owner's convenience without using electricity.

Scientists classify luminescent materials into three or more distinct kinds, according to their behavior, which in turn decides which is best suited for a given use.

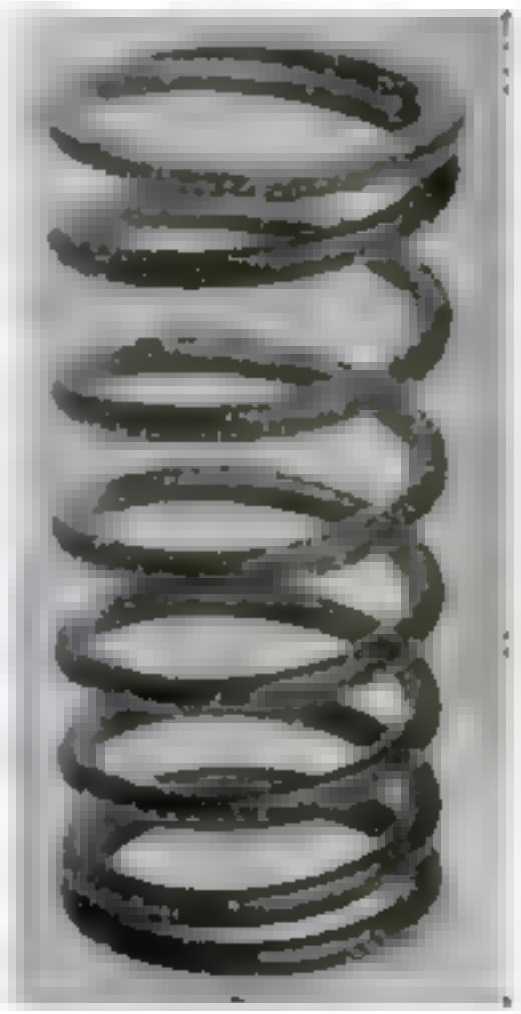
Fluorescent substances glow just so long as they are exposed to ultraviolet rays—popularly known as black light—and no longer. This property has suggested the war use of fluorescent buoys to guide friendly ships through channels in mine fields, when illuminated momentarily by a black-light searchlight. Of the many known fluorescent minerals, some are ores of strategic war metals. Important deposits of tungsten ore have been located by night prospecting with black-light equipment.

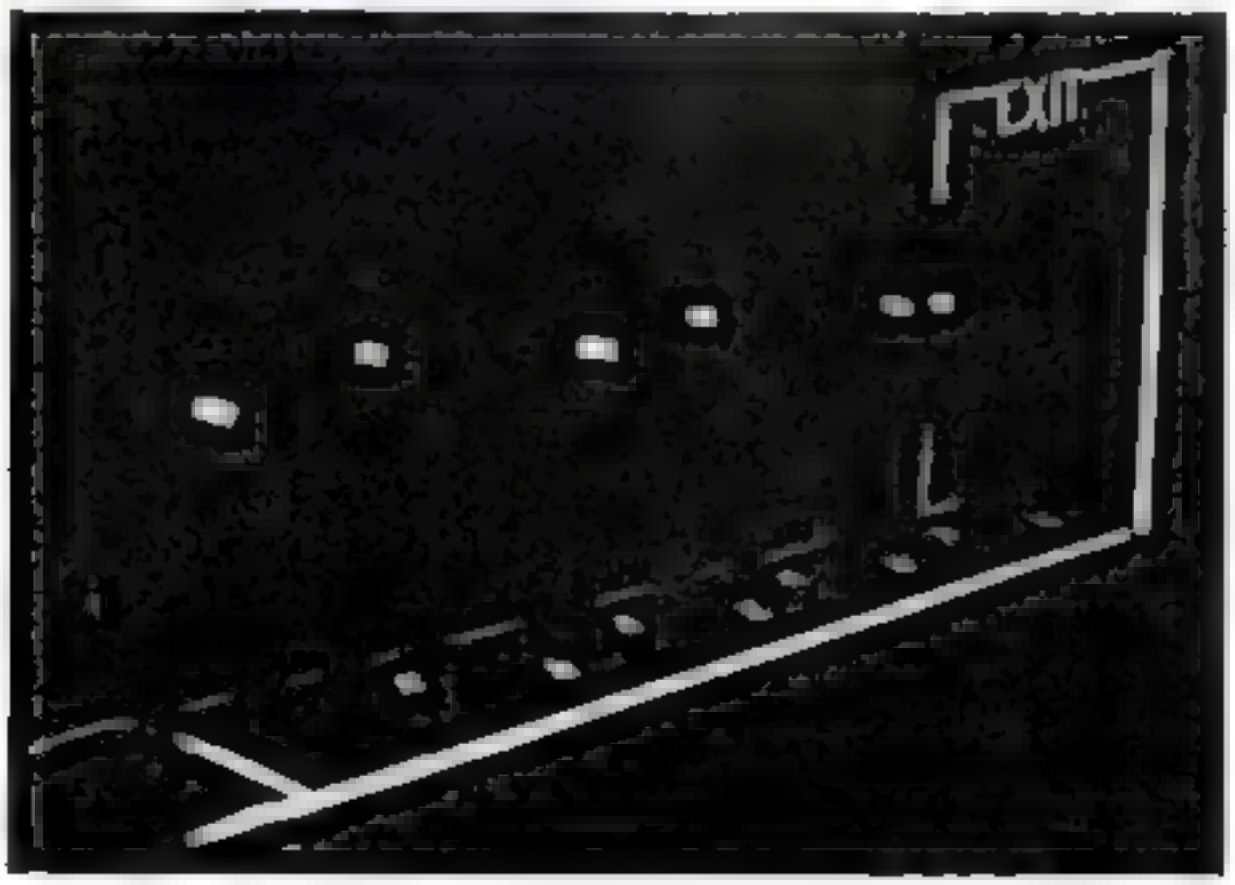
Phosphorescent materials soak up illumination from the sun or from artificial light. Then they proceed to reradiate it for several hours, without exterior stimulation. Luminous paint made from such substances provides all-around service and is unaffected by power failure. One of its former disadvantages—that it could not be extinguished at will—is now reported to have been overcome by Gilbert T. Schmidling, a pioneer American research worker in the field. By illuminating it with strong red light, he says, the phosphorescence can be "put out." Subsequent illumination with sunlight turns it on again.

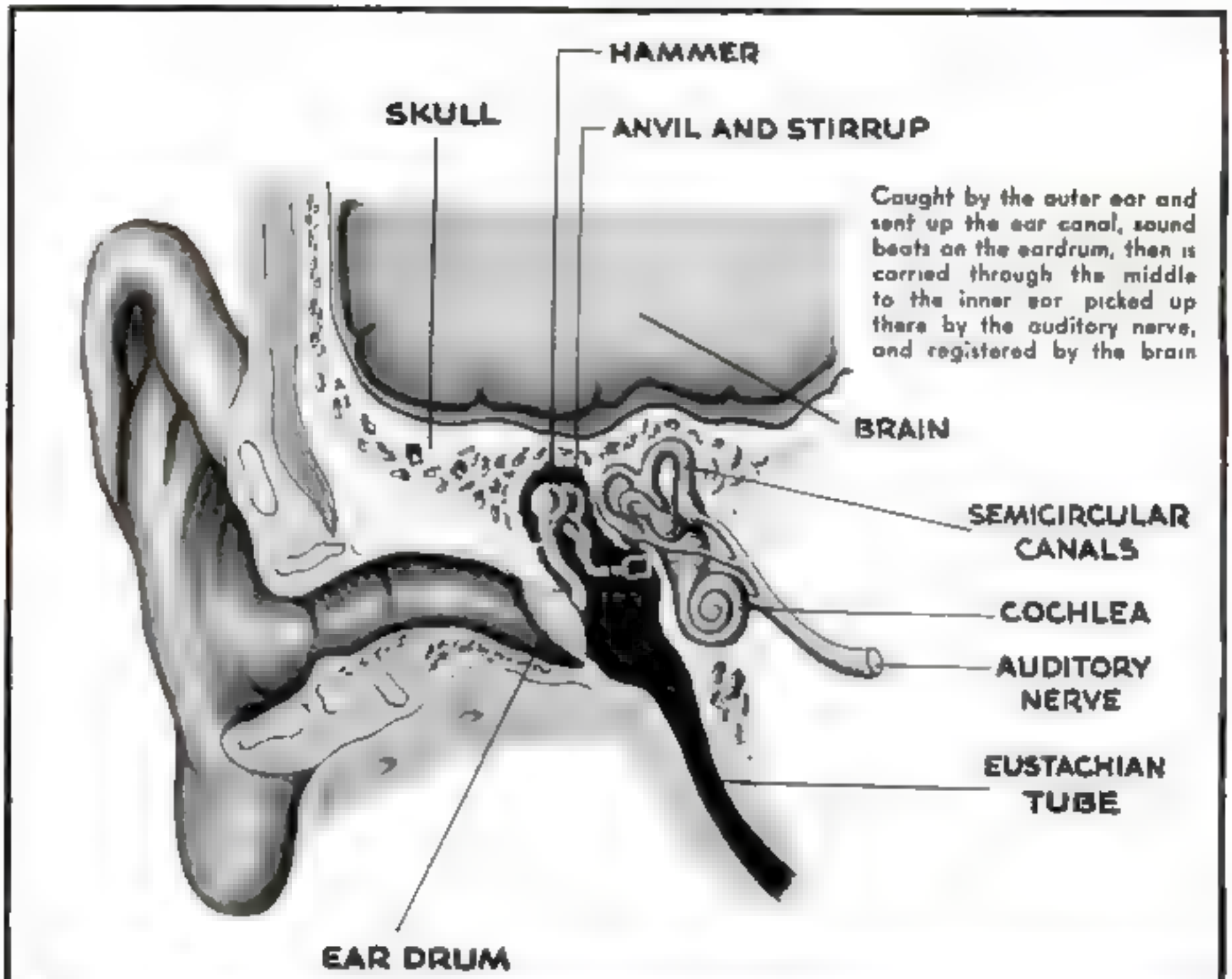
Self-illumination, or autoluminescence, occurs spontaneously from a variety of chemical and physical actions. The firefly, nature's prize example, owes its glow to a slow form of chemical oxidation, which has been duplicated in the laboratory. Crystals of saccharin emit light when crushed or rubbed together. The luminous paint employed on watch dials provides permanent light by bombarding a metallic sulphide with rays from radium.

LUMINOUS MATERIALS HELP INDUSTRY TO "PLAY SAFE"

To protect its workers in the event of a power failure or blackout, a Philadelphia plant has outlined the doorway and ramp shown below with a phosphorescent paint. Note that the workers also wear luminous arm bands. A luminous metallic powder is also being used to detect manufacturing defects. Dusted on the magnetized coil shown at the right, it glows under black light to reveal a flaw down the full length of the coil







What do You Know About

Nature gave you a marvelous pair of hearing instruments . . . Modern tests show how they are best protected and used.

Drawings by JOHN GILMORE

SAY "Good morning" to the first 15 people you meet, and at least one of them probably will have to guess at what you said. Or, if all of them hear you clearly, *you* may be the one in 15 who has defective hearing. That, according to a recent estimate made by the New York League for the Hard of Hearing, is the average ratio of deafness, whole or partial, in the United States. Some people are born deaf, but most defective hearing is acquired as a result of disease, injury, or neglect. Economic as well as personal and social problems are a result; more than 40 percent of those with acquired deafness have had to change their occupations.

Fundamentally, the human ear is a simple mechanism and shouldn't be hard to take care of. It is a funnel which catches sound waves, converts them into nervous impulses, and sends them to the brain to be sorted out and classified. Man has taken the same basic principles and made the relatively simple telephone transmitter, which catches sound waves and converts them into fluctuating electrical impulses. In detail, however, the ear is a complicated set of physical gadgets, like most of nature's machines.

There are three major parts: the outer ear, the funnel which catches the sound; the middle ear, which transmits the sound; and the inner ear, where the auditory nerve picks up the vibrations and sends them along to the brain. The middle and inner ears are the most complicated, the most easily injured, and the hardest to repair.

The outer ear consists of the familiar flap of cartilage sometimes called the "shell," and the auditory canal which extends inward to the eardrum. The eardrum is a membrane that stretches across the auditory canal and separates the outer from the middle ear. Another name for the eardrum is the tympanic membrane, and it acts like the head of a drum, vibrating when sound waves strike it as a drumhead vibrates under a drumstick.

On the far side of the eardrum, in the middle ear, are three small bones called ossicles. The "hammer" rests on the eardrum and responds to the sound vibrations, which it in turn taps out on the "anvil." The "anvil" passes them along to the "stirrup," which fits into an opening in the inner ear and touches the cochlea, the apparatus which changes sound vibrations into nervous impulses.

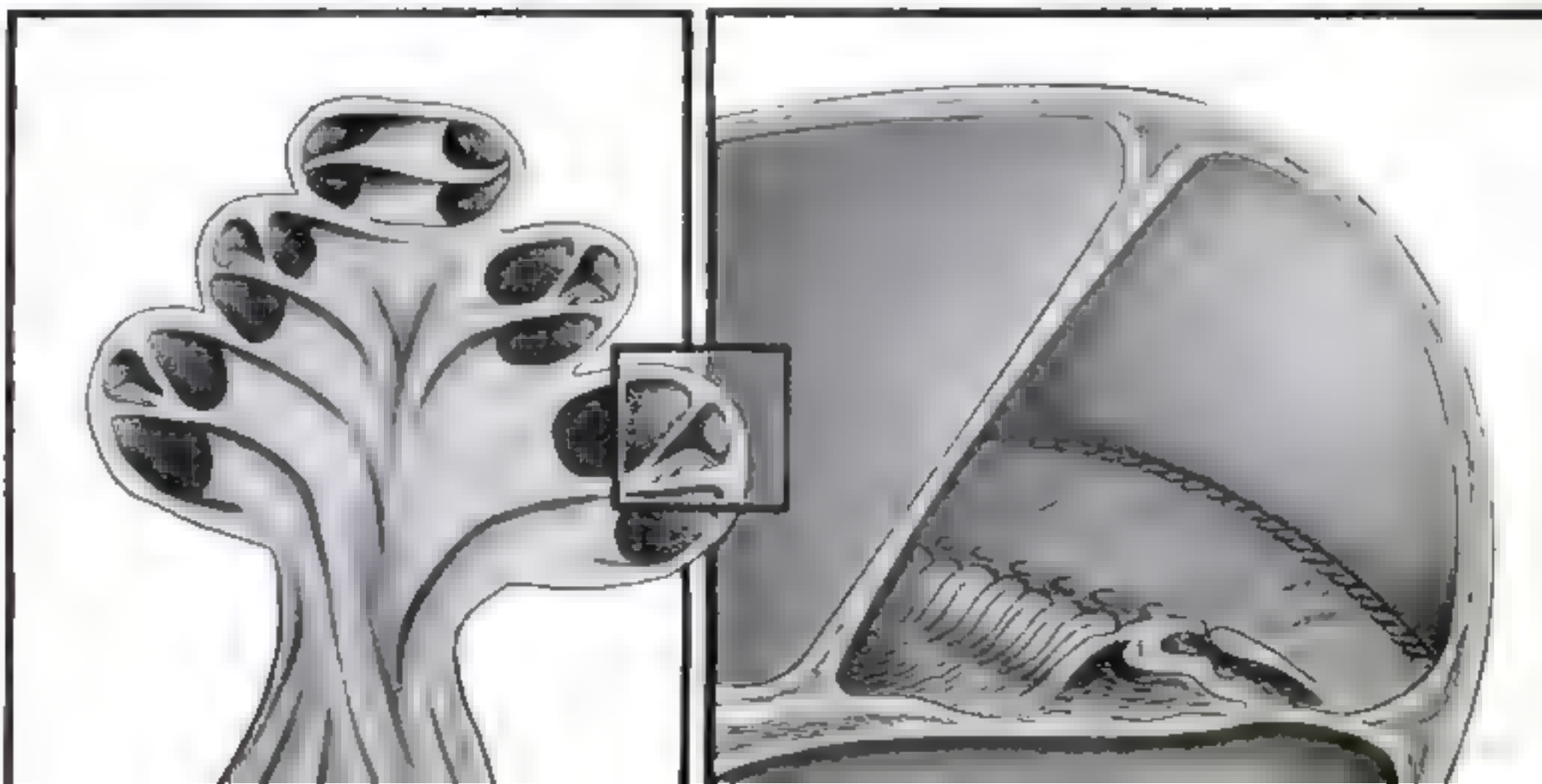
The cochlea is a tiny organ, coiled like a snail shell and filled with a thick fluid. On its inner walls are sensitive, hairlike terminals of the auditory nerve. When the sound waves are tapped out on one end of the cochlea by the "stirrup" bone, the fluid inside is set to vibrating, the nerve terminals are agitated, and the message is started along the auditory nerve toward the brain.

The cavity of the inner ear, where the cochlea lies, is in one of the hardest bones in the body, a fact important in the use of one type of hearing aid. Also in that cavity are the "balancers," three little tubes coiled into connected semicircles and set at right angles to each other so that they look something like a distorted pretzel. They have nothing to do with the sense of hearing; they are the center of the sense of equilibrium—the body's leveling instrument. Head colds and ear infections sometimes disturb them and cause dizzy spells. When a cold affects the sense of hearing, it is because the Eustachian tube, which connects the middle ear with the throat, is swollen partly shut. The Eustachian tube's function is to equalize the air pressure on the two sides of the eardrum.

A serious infection in the aural passage, or even the rupturing of the eardrum, can be caused by sticking a match stick, hairpin, or the corner of a towel into the ear to re-

Your Ears?

Below, left, is seen a cross section of the cochlea, the receiving instrument of the inner ear. The fluid with which the canals are filled is set in motion by sound waves. At right, an enlarged view of one section of a canal. The hairlike antennae of the auditory nerve pick up the vibrations of the fluid and transmit them to the brain. In the lining of the cochlea there are said to be more than 23,000 tiny nerve cells



move water, wax, insects, or other foreign matter. In such cases only a few drops of warm oil should be used. If that doesn't remove the object, then a physician should be consulted promptly.

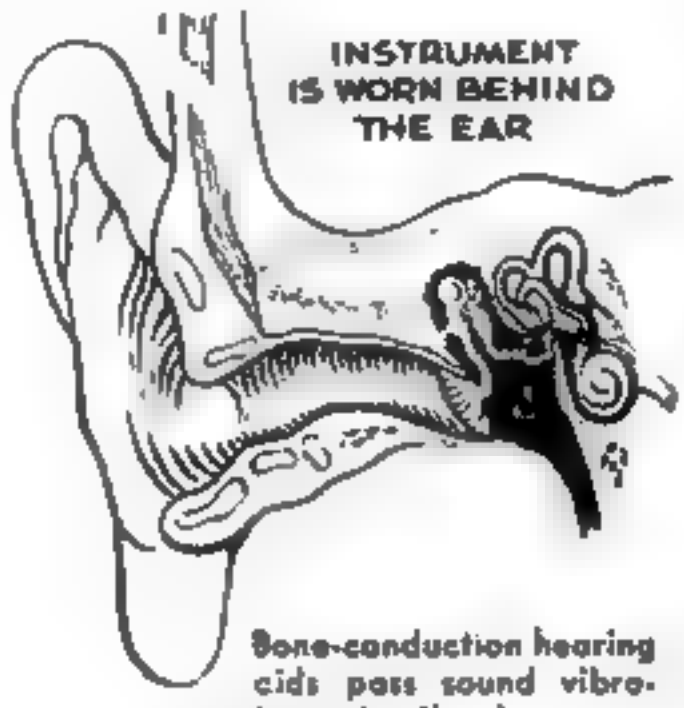
Treatment of impaired hearing is in many cases both simple and effective. Far more trouble is caused by refusing to admit that one's hearing is not up to par, or by trying to conceal the fact, than by poor hearing itself. The person who tries to answer a question or follow an order only half heard may say or do something inexcusably stupid in the attempt to "cover up." More jobs are lost by trying to conceal poor hearing than by the difficulty itself.

Thanks to scientific research, partial deafness can now be repaired almost as easily as nearsightedness. The chief problem is to find the trouble—and to get the patient to acknowledge it to himself.

Tests in schools have been especially effective in spotting deafness at a time when medical aid can be of particular help. Many children who seem to be backward or stupid are found to be only hard of hearing, and treatment often brings them up to par in their studies.

The old-fashioned hearing tests, based on voice tones or the tick of a watch, served in their day but gave no accurate measure of the degree of deafness or the reason for it. Now the audiometer is used, an instrument which Dr. Fred W. Kranz, physicist and research director of the Sonotone Corporation, calls the first accurate device for measuring hearing. With the audiometer, standards of normal hearing have been established, and tests with it show not only the degree of hearing loss in any individual but whether the source of the affliction is in the middle or the inner ear.

Once the source and degree of deafness are ascertained, various kinds of hearing aids can be prescribed. The Sonotone Research Laboratories, for instance, have developed two types of electrical hearing aids, one for air conduction, the other for bone conduction. Both work on the same principle as the telephone: the transmitter picks up the sound waves, changes them to electrical impulses, and sends them to a receiver which changes them back to sound waves or vibrations where the defective ear can best make use of them. The air-conduction type of hearing aid sends the receiver's sounds directly into the ear passage. The bone-conduction type, which is worn behind the ear rather than in it, sends sound vibrations through the bone directly to the cochlea in the inner ear.



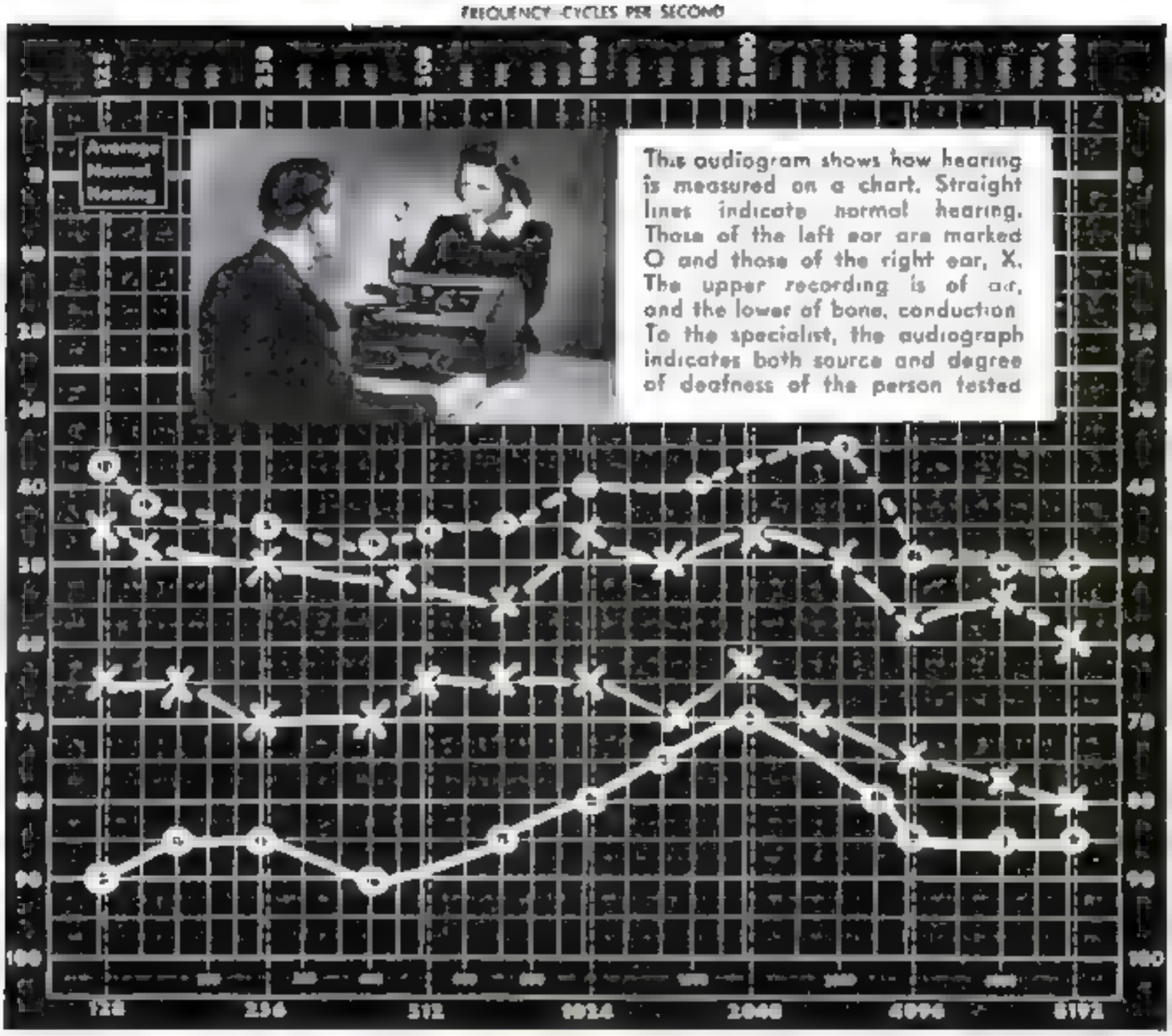
Bone-conduction hearing aids pass sound vibrations to the inner ear

Recently, radio principles have been adapted for use in hearing aids. The transmitter in this type of instrument uses a Rochelle crystal instead of carbon grains. When the crystal is activated by the vibration of a diaphragm, the strength of the electrical current through the crystal is varied and the sound waves are converted into electrical impulses. Miniature vacuum tubes are used for amplification in the receiver. The result is very different, both in appearance and effectiveness, from the ear trumpet of grandfather's day.

With all these advances in understanding and treatment of hearing defects, there is seldom any excuse for a person who suffers from partial deafness. In the first place, you should know enough about your hearing equipment to give it reasonable care. If it fails naturally, give it scientific aid.

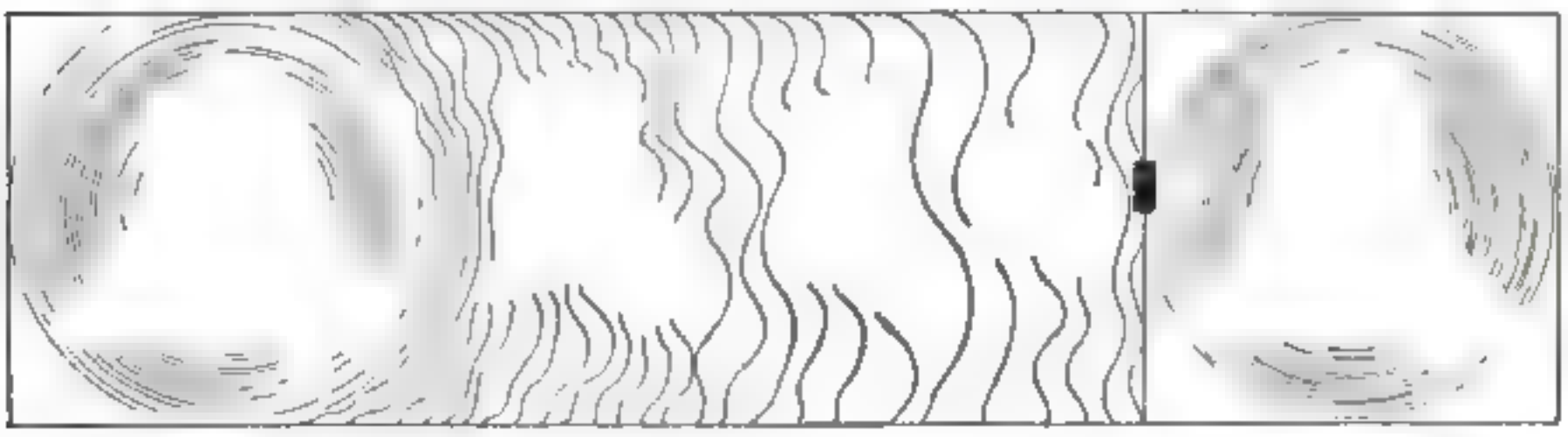
Helpful Earful

NEVER box a child's ears, or hit him on the side of the head.
NEVER try to remove objects that a child has put into his ear. Take him to a physician.
NEVER clean the ears with a hard or pointed object.
NEVER dry water-filled ears with a towel. Tilt the head and let them drain.
NEVER fish for an insect that has got into the ear. Go to a physician or pour ear drops or warm oil into ear until insect drains out.



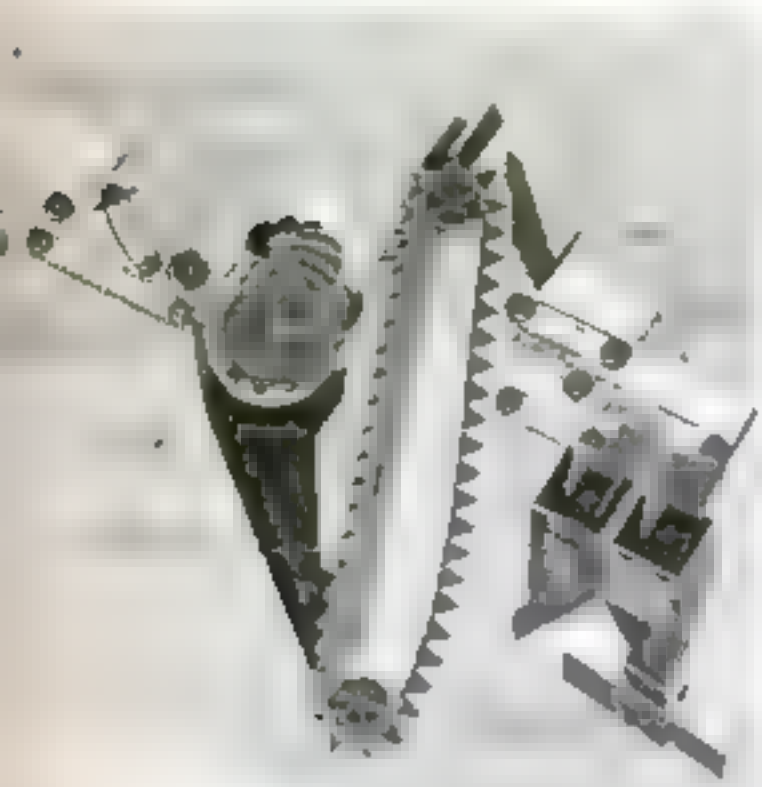
THIS SHOE SHOULD FIT

Even to the partly deaf, some sounds are distorted and unintelligible, while others are wholly unheard. The diagram above shows how unevenly a typical sentence is heard by a deafened ear. Below, two important functions of hearing aids are shown: distorted frequency waves must be corrected for clearness, and every sound must be amplified to suit the requirements of the user



HOW 10 TONS OF BOMBS can be carried by a Flying Fortress is shown strikingly in this view of one of the big Boeing bombers on a practice flight near Mount Rainier in the State of Washington. Outside racks with forklike fingers hold the extra bombs on the bottom of the fuselage near the landing wheels. This supplementary arrangement permits the carrying of an unusually heavy load for limited-range operations.

SHREDDED AND NEATLY BALED in 200-pound packages, tin cans, automobile bodies old stoves, and all kinds of scrap iron are made ready for reprocessing in a huge machine devised by Clarence M. Gregg, president of the Los Angeles By-Products Company. Chrome molybdenum hammers or cutters on the outside of a drum revolve at 1,800 r.p.m. to break up the pieces into tiny bits, which ride through a magnetic separator that deposits dirt and nonferrous metal in one bin and iron in another. Automatic balers then bind the iron scrap into bales of uniform density



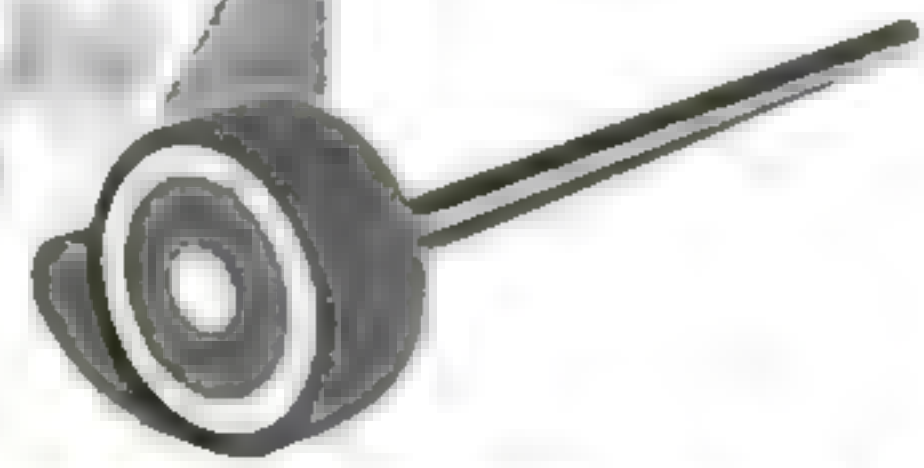
Scrap is fed into this giant machine on a conveyor, goes into a five-ton shredder, and comes out in neat bales

A BOMBPROOF LABORATORY for processing photographic material at the front has been designed by the 165th Signal Photographic Company at Fort Sam Houston, Tex. As shown in the drawing by military artist Swanlund, the underground darkroom provides a working space of about six by 12 feet and is entered through a protective right-angle passageway. One of its features is a ceiling rack in which a camera can be placed as demonstrated by Sergeant Smoody in the photograph above for use in making enlargements. Heavy sandbagging guards against damage by bombs and shells, so that work can be carried on under fire.

LANDING GEARS that stick need no longer threaten pilots or their planes. Engineers of Walter Kidde & Co. have developed a carbon-dioxide power unit which, in an emergency, can be used to lower landing gear or open and close bomb-bay doors. Because of the high compression of carbon dioxide, a two-pound cylinder is sufficient to operate even the heaviest equipment.

GIANT ENCLOSED MOTORS, such as the one shown below, are being built by General Electric for tankers of the U. S. Maritime Commission. Each motor has a sheet-iron cover as a protection against dirt, and is equipped with an air-recirculation system. Cool air entering at the bottom of the motor rises as it becomes heated and is then piped off into a cooling blower, which carries it back to the bottom of the motor.

ALNICO MAGNETS set in the bases of the standards are simplifying the setting up of experimental optical systems. Adhering to a metal table top or wall, the magnets hold the system in position and prevent any disarrangement even when adjustments are made. This use of alnico was devised by Norman Barnes of General Electric.



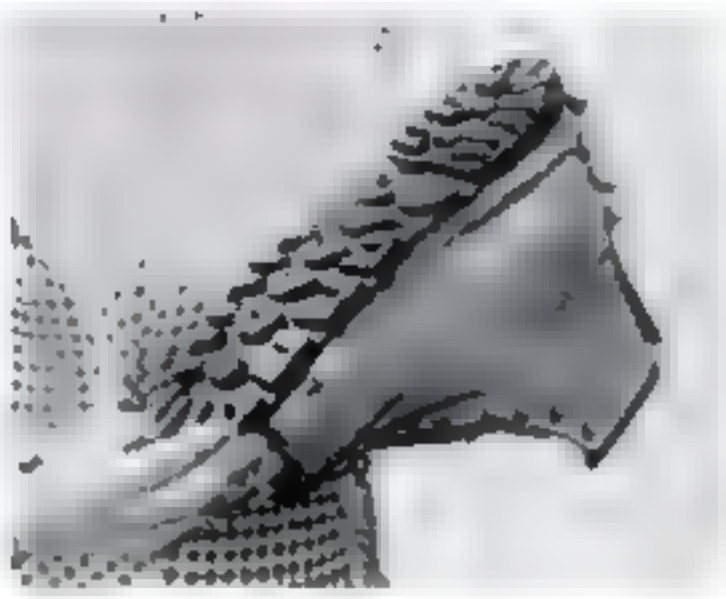
Although standards will adhere firmly to any steel surface, they can be easily moved when necessary. At right, a bottom view of a standard, showing an alnico magnet set in its base

NEW GASOLINE OVENS are being used by the U. S. Army Quartermaster Corps for baking in the field. Shown at right are eight of these two-chamber ovens, which can do the baking for 10,000 men. Tended by a bakery platoon of 36 men, and using 3,600 pounds of flour, this battery of ovens can turn out 5,000 pounds of bread in 24 hours. Below: fire-control units.

A BRAKE TESTER for airplanes has been developed by the Safety Equipment Co., of South Bend, Ind. The device cradles the plane's rubber tires between rollers that provide traction equal to that of dry concrete. When the brakes are applied, the force needed to turn the wheels is registered on a dial, which gauges the braking action.

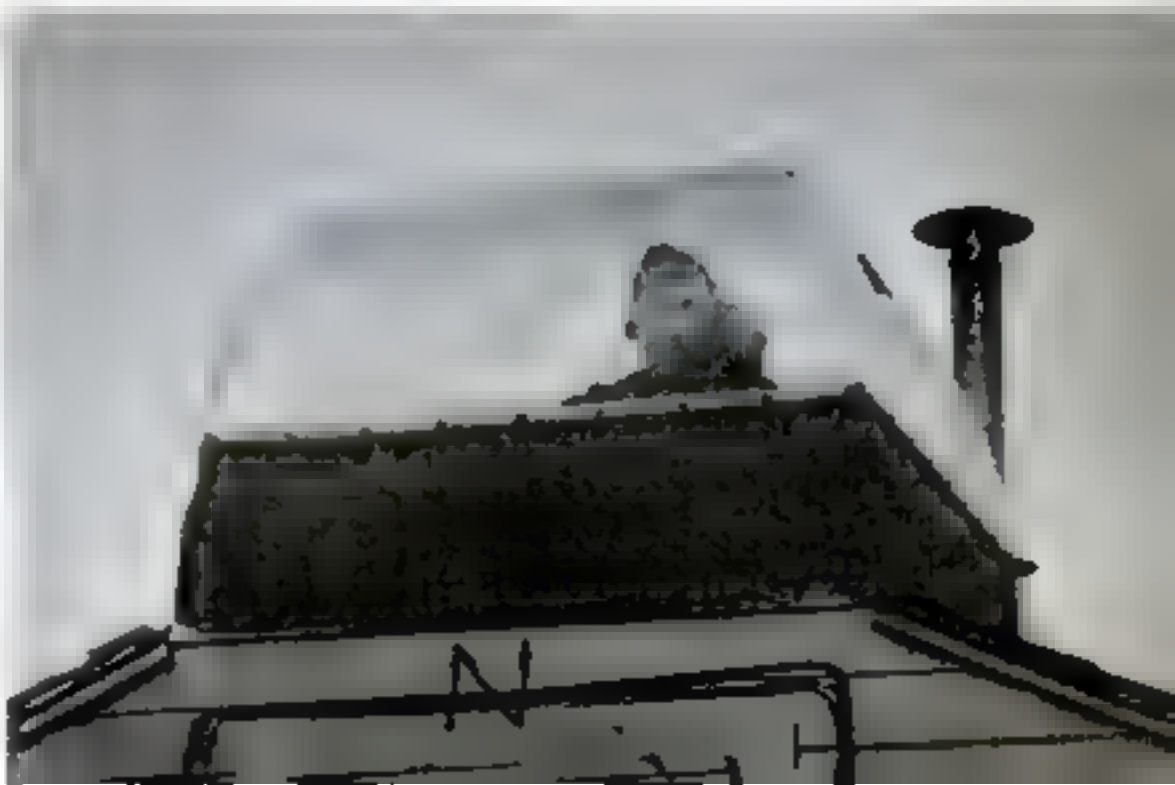
POPULAR SCIENCE

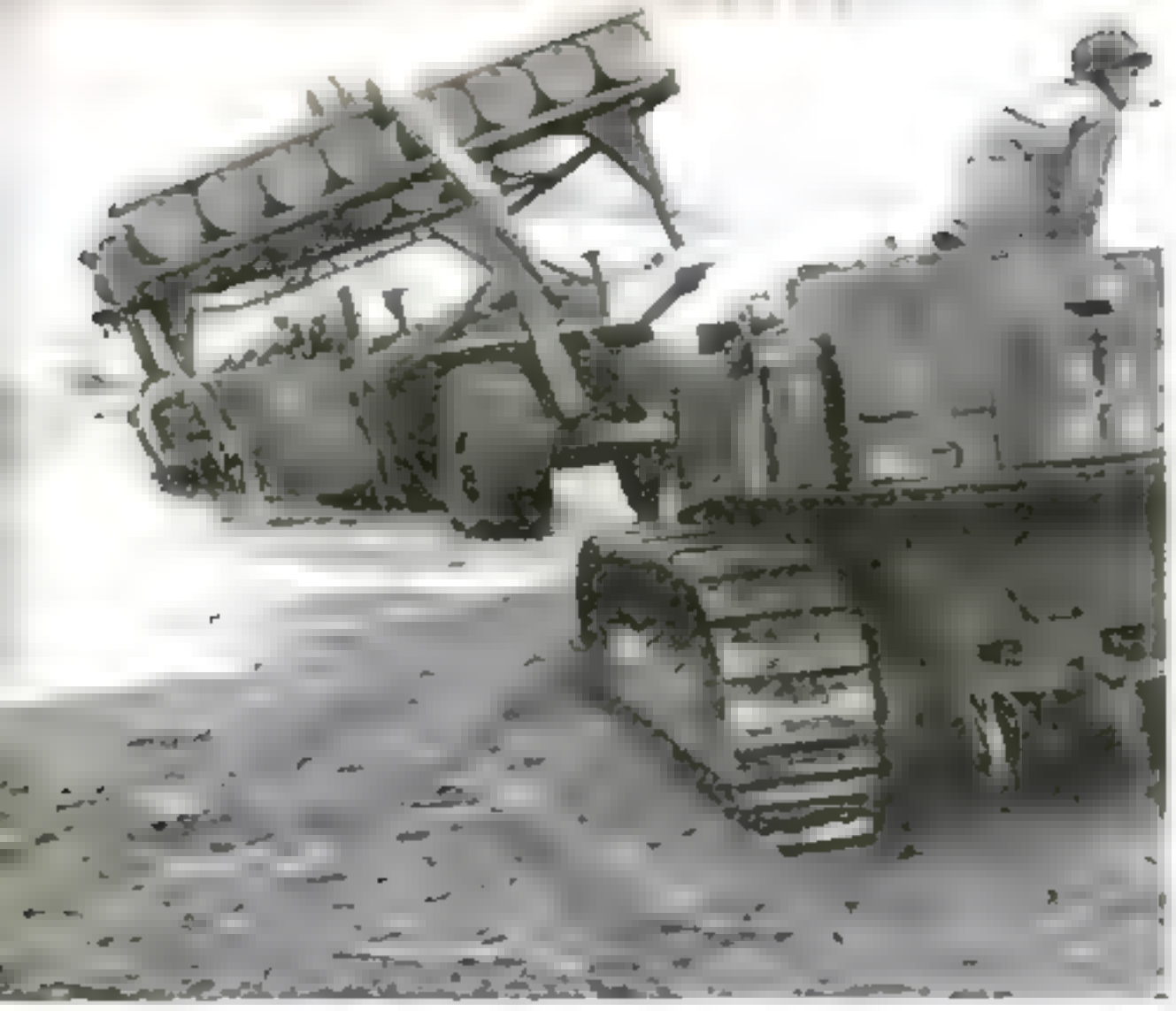
AMPHIBIOUS FLOATS, attached experimentally to the Army Air Forces' C-47, may make this big cargo transport an efficient seaplane as well as a land plane. Tried out at Wright Field, Dayton, Ohio, the new floats enabled the plane to alight on water, taxi to shore, and climb on land under its own power. This may prove particularly useful in rescues of flyers on coral reefs in the Pacific. Further experimentation is being carried out by the AAF in the design and use of the floats.



RUBBER-CLEATED SOLES AND HEELS are being put on ski boots for our soldiers, who may be using them soon to cross the Alps for a closer crack at Hitler. Replacing the steel cleats and leather worn by mountain troops in World War I, this footwear was developed by Adams Carter, famous mountain climber and now a research specialist for the Quartermaster General, and experts of the Goodyear Tire & Rubber Company. The design, an improvement on a Swiss-Italian shoe, is light, warm, waterproof, and silent on flinty surfaces.

CLEAR PLASTIC DOMES are being mounted on open antiaircraft observation posts along the Atlantic seaboard to keep sky watchers dry and comfortable. Built of Lumarith, made by the Cellanese Celluloid Corporation, of New York, the domes offer shelter from rain, sleet, and snow without cutting visibility, and also improve communication by screening out noise.





Hauling a landing barge ashore on Attu with the help of a tractor and an odd but efficient movable dry dock called a "geeheebee"

"GEEHEEBEE" is the name that U. S. soldiers and sailors have given to the odd contraption shown at the left. Much in evidence where amphibious operations are in progress, it performs yeoman service when repairs or repainting must be done on the landing barges and other small invasion craft.

The "geeheebee" is backed by a tractor into the surf until it settles over a landing boat or other small craft, which is then chained to the frame. As the tractor pulls the two ashore, the boat is lifted clear of the ground. After repairs have been completed, the procedure is reversed to relaunch the craft. Empty oil drums on the "geeheebee" permit it to be floated ashore from a transport or other large vessel.

PLASTIC EAR STOPPERS are now molded from Plexiglas to fit the ear canal. Designed by Arthur F. Farman, an employee at McClellan Field in California, they are manufactured by Rohm & Haas Company, of Philadelphia, Pa.

TWIN THREADS are a new idea for screws for wood, plastic, and combination assemblies. These screws, made by the Blake & Johnson Company, of Waterville, Conn., have straight sides, relieved shank diameter, and a single balanced point.

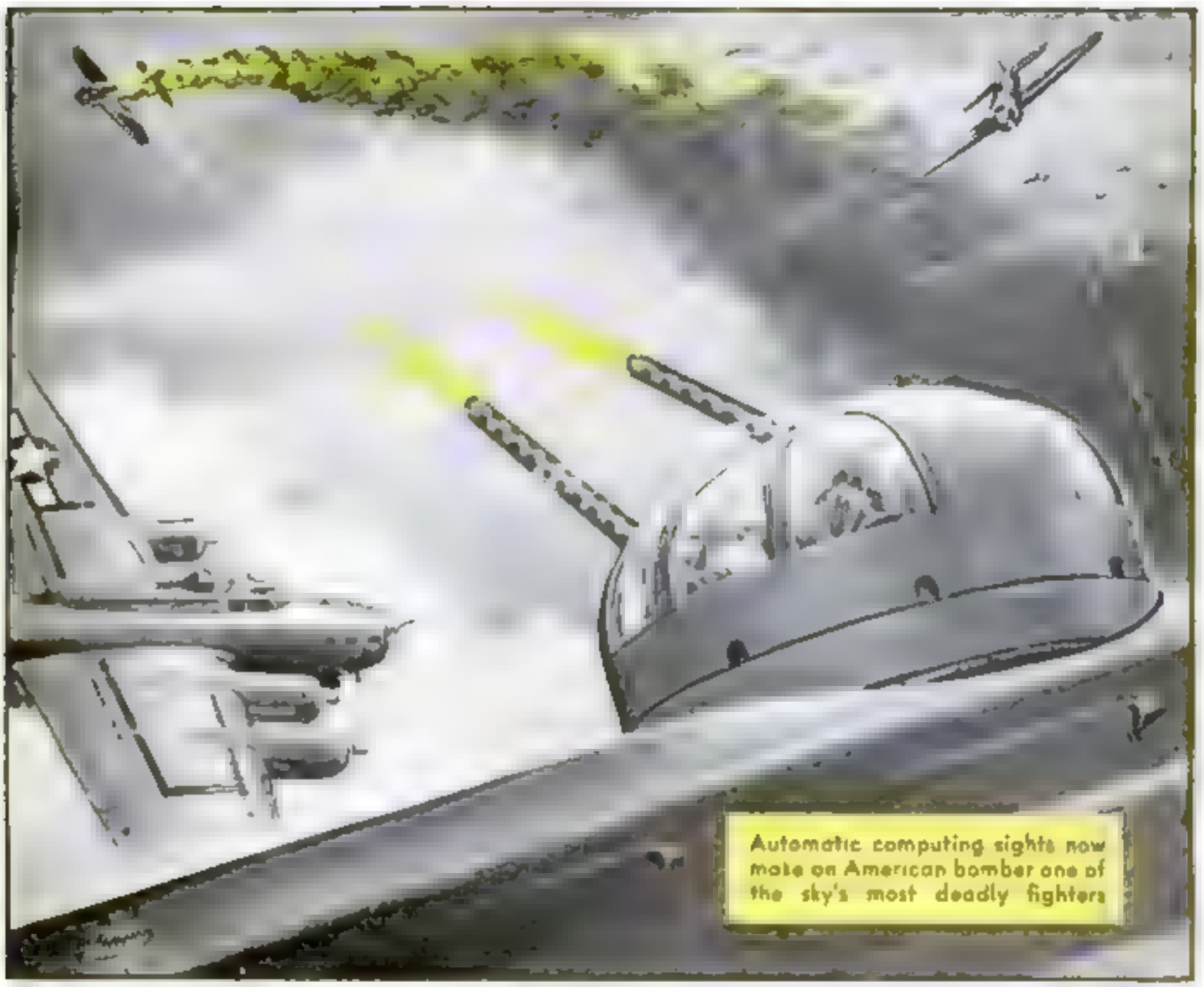
TWO MEN OPERATING this grid machine, developed by Lyle F. Pierce, chief of master layouts at the Boeing plant in Seattle, can make in one day a crosshatched background for full-scale mechanical drawings that once took six months. The machine scribes simultaneously 12 parallel lines 100 inches long and accurate to .005 inch.

Backgrounds thus made on painted steel are joined together, sometimes into sheets 20 by 30 feet, for bases on which full-size drawings are put for parts of Boeing planes.

POPULAR SCIENCE

WATER JETS that can peel the bark off giant logs more swiftly than knives are the basis of a hydraulic barking machine developed by the Weyerhaeuser Timber Co. of Everett, Wash. Twin nozzles on a moving carriage force streams of water up against a rotating log at a pressure of 14,000 pounds per square inch, producing erosion of bark and cambium. Steel arms steady the log. Six-foot trunnes can be stripped in a few seconds.

"STICKY" BOMBS that are thrown by hand and glue themselves against their targets have now been revealed as one of the secret weapons the British Eighth Army used so successfully in the African campaign. The bomb consists primarily of a glass flask filled with a short hand-grenade fuse and filled with an explosive. Wrapped around the flask is a tight-fitting wooden jacket that has been treated with a special adhesive. When hurled against a tank, the bomb fastens itself there for several seconds, then explodes. For protection before throwing, the bomb is fitted with a finger-retaining ring held together by a narrow metal band wrapped around the neck of the bomb, as shown at the right.



Why our aerial gunners are

Outshooting the Axis

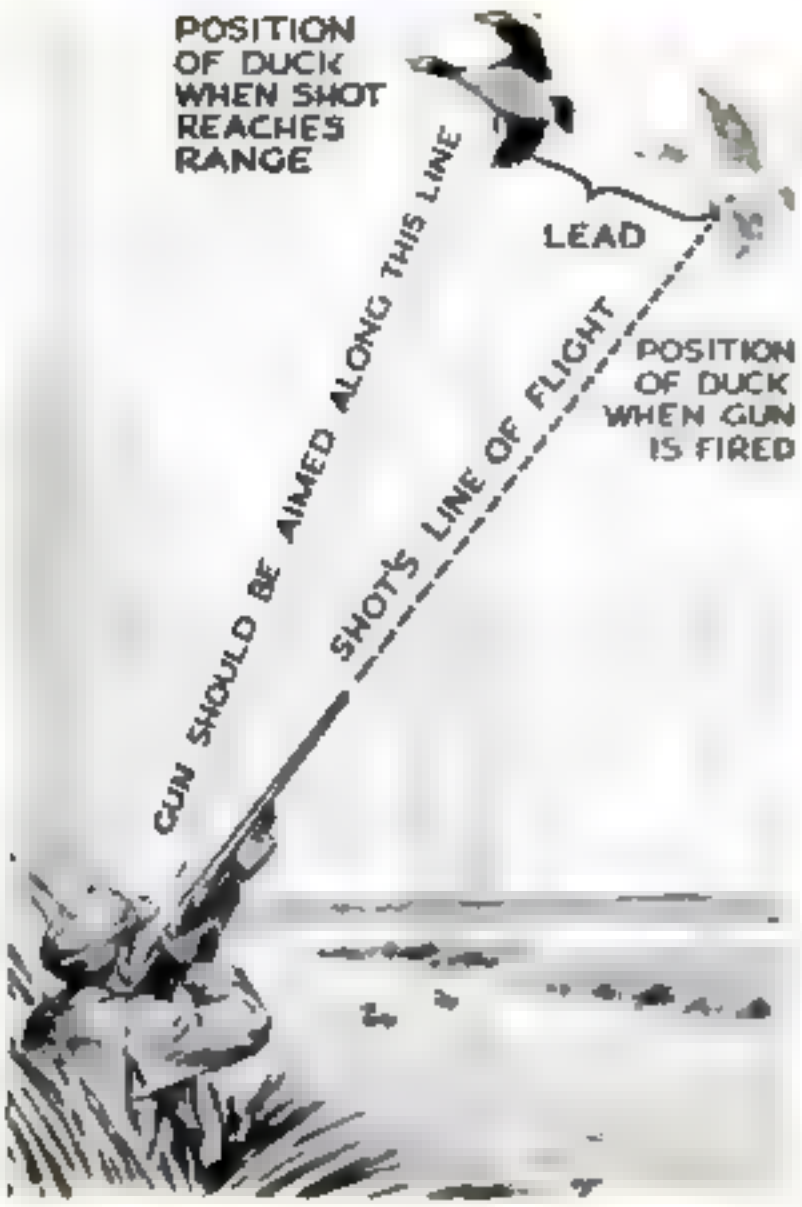
By HAL BORLAND
Drawings by FRANK TINSLEY

AMERICA'S big bombers, which roared to fame as tough ships that could "lay eggs in a basket" from 20,000 feet and take terrific punishment, are even more famous now as killers of the sky. On one bombing mission, not long ago, a flight of them knocked out 74 Nazi fighters. Good to begin with, they are now superbly lethal.

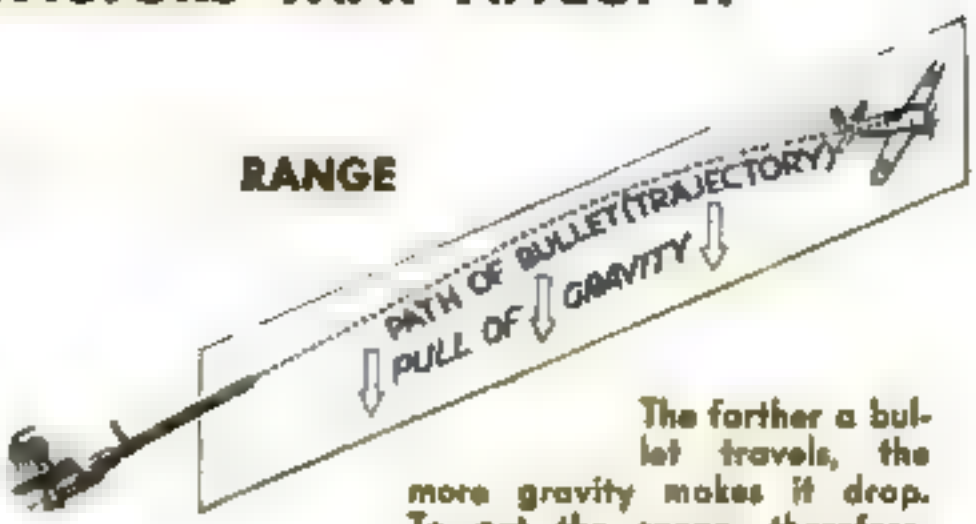
How come? The answer is gunnery—gunnery that is more than weapons, more than power turrets, more than competent gunners. It is all these, plus an automatic computing gunsight that makes supermen of the bombers' gun crews. This automatic sight has given our big ships a fire-power "reach" of more than 1,000 yards, or twice the effective range of Axis aerial guns.

Until recently this automatic sight was a secret weapon. Its details are still secret, but the veil has been lifted enough to show what it can do and, in general, how it does it. Basically, it is a compact machine that automatically calculates speed, drift, windage, trajectory, and range, and compensates for all these factors as it aims the guns where the bullets will do the most damage to an enemy plane. It does all this with a minimum of human effort, and reduces human error to a minor factor by eliminating virtually all guesswork. And, lastly, it is so simple to operate that three weeks' training with it can make an expert gunner out of a novice.

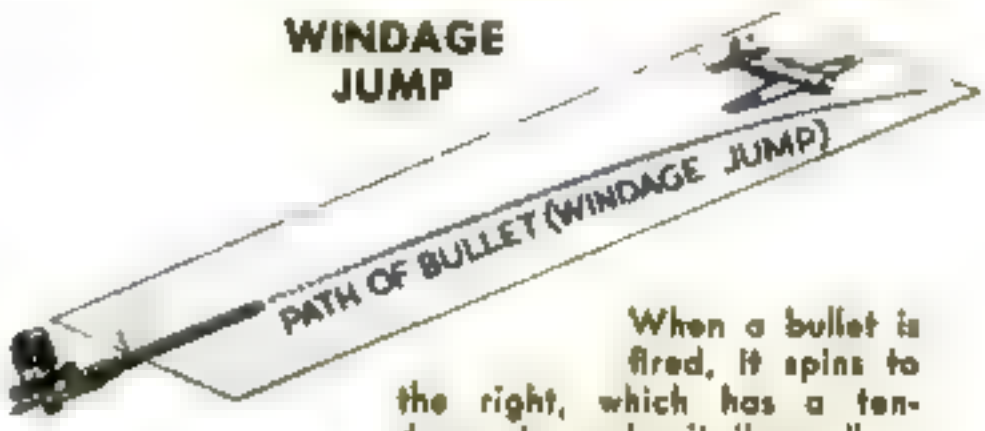
LEAD—AND THE VARIOUS FACTORS THAT AFFECT IT



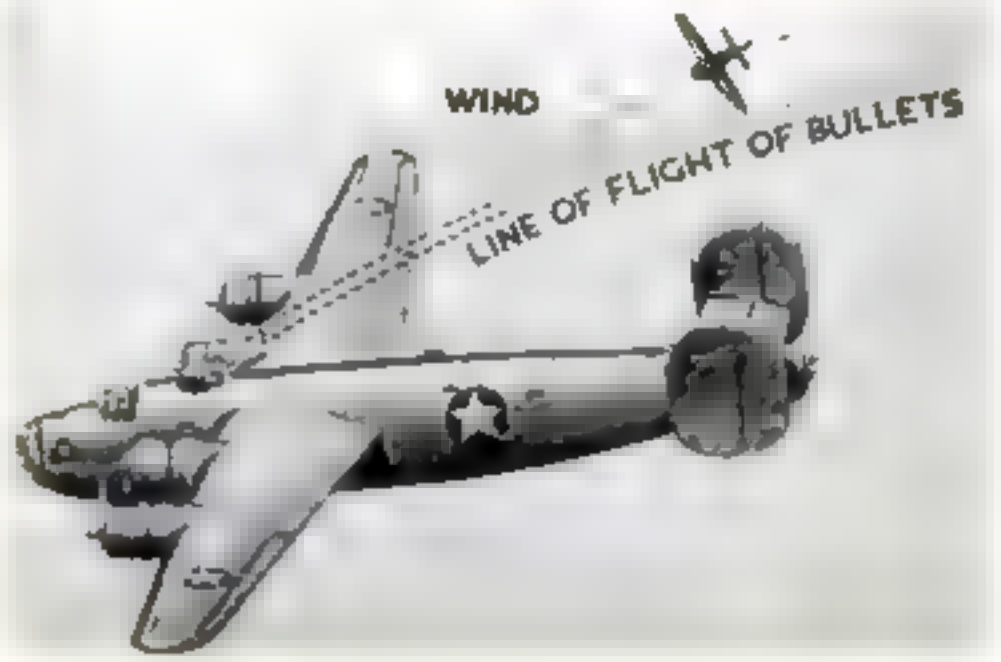
LEADING consists of aiming ahead of a moving target so that the bullet and target will arrive at the same point simultaneously. In sketch above, the hunter will miss his target because the duck will have moved ahead during the flight of the bullet



The farther a bullet travels, the more gravity makes it drop. To get the range, therefore, gun muzzle must be elevated



When a bullet is fired, it spins to the right, which has a tendency to make it "jump," or veer off, in that direction

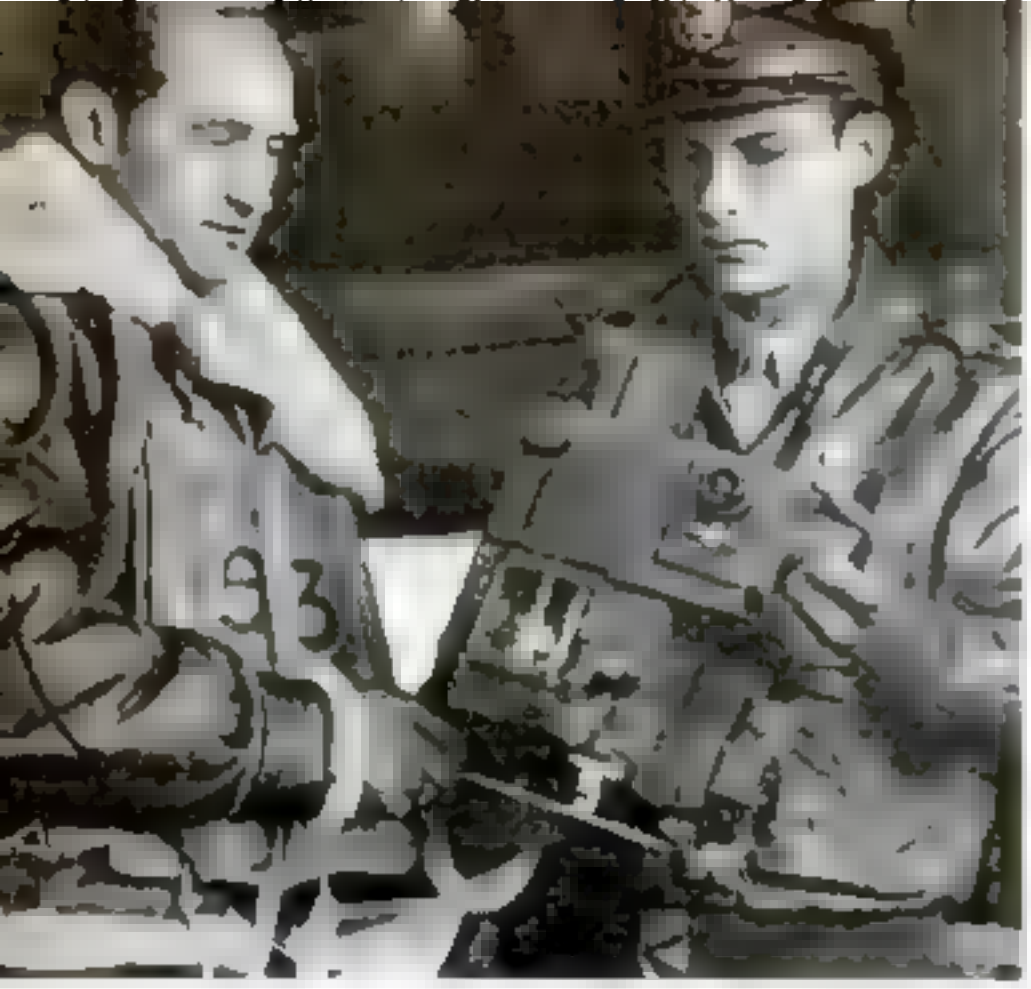


WINDAGE. As the bullets leave the plane's guns, the wind rushing past the plane has a tendency to deflect them toward the tail. The degree to which this force of wind will change the direction of the bullets' flight is determined by the speed at which the airplane is flying

Any duck hunter or trapshooter has a rough idea of the primary problems of an aerial gunner. First of all, to hit a moving target he must "lead" it, that is, shoot far enough ahead of it to allow for its speed. Then he must take into account the range of his gun, the effect of the wind, and the characteristics of the shell he is shooting.

The duck hunter's target, however, seldom flies more than 60 miles an hour. The aerial gunner's target travels more than six times as fast. And while the duck hunter shoots from a stationary position, the aerial gunner is in a bucking, twisting ship traveling at least 200 miles an hour. The duck hunter uses a shell whose hundreds of tiny pellets are deadly over a three-foot circle at 50 yards. The aerial gunner's weapon fires only one bullet at a time. To approximate the aerial gunner's task, the duck hunter would have to do his wing shooting with an automatic rifle while sitting in the rumble seat of a car going down a country road at 30 miles an hour. Accurate shooting from a big bomber with manually operated weapons and ordinary sights is phenomenal. Man simply is not physically equipped to do it.

Of his equipment, his eyes are probably nearest to the necessary perfection. When a bomber is flying at 200 miles an hour and an oncoming pursuit ship is moving at 400 miles an hour, the combined speed of approach is 300 yards a second, which is not



SIGHT AND TURRET. At the left, an officer carefully examines one of the automatic computing sights before it is installed between a turret's two guns. Above, a gunner grins as he crawls into the belly turret of a big bomber

very far from the speed of sound. Yet a gunner's eye can follow a pursuit ship traveling at that terrific speed. In a wink of the eye, however, the target will have moved about 25 yards. And we know from optical research that persistence of vision makes the eye incapable of registering an abrupt change lasting less than 1/32 of a second. The eye is fallible to a degree not yet fully determined; but, on the whole, it is good enough for the aerial gunner's job.

A man's physical reflexes are less dependable. But because of their importance, the Air Forces insist on high standards. Impulses from the eye or ear must be obeyed by the muscles without perceptible delay. Tests of thousands of automobile drivers have shown an average reaction lag of .44 second. Yet in half that time an aerial gunner's target may move as much as 66 yards. A trigger finger even a tenth of a second late in obeying the eye's order to fire would put the burst of fire completely off the target, even if no other factors were involved.

Mental processes are another factor. The best mathematical mind isn't fast enough to solve, at a given instant, a problem dealing with air speeds of hundreds of yards a second, particularly when such complex matters as windage, drift, trajectory, and range are also involved. That is why the guns in a fighter plane are in fixed mounts; they can be aimed by pointing the plane itself, and no complicated calculations are necessary.

Add to the gunner's problems the fact that high altitudes slow up both physical reflexes and mental processes, and then the situation becomes really complicated. Oxygen helps to compensate for the altitude, but low temperatures—it gets down as far as 45 below zero F. at 25,000 to 30,000 feet also tend to retard the reflexes.

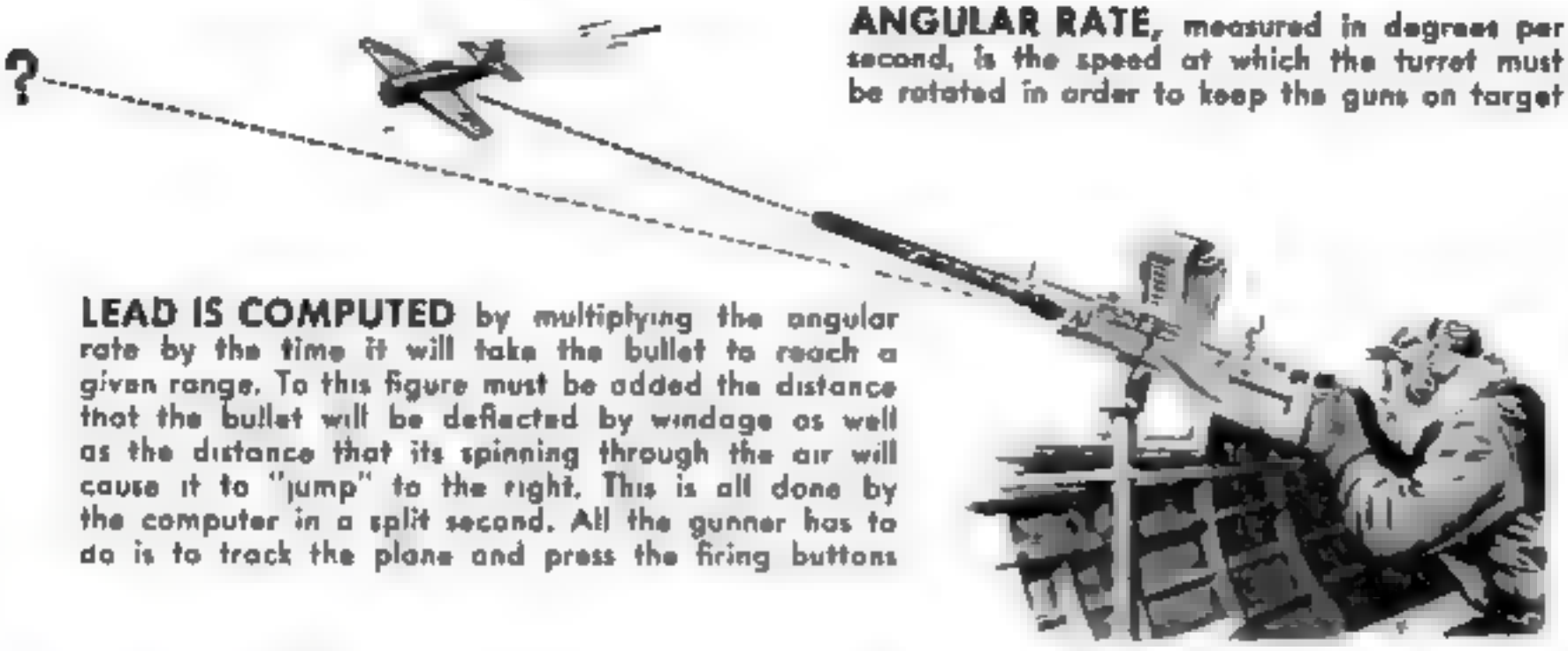
The automatic computing sight was developed to minimize all these human factors. It is a mechanical Einstein that literally computes half a dozen complex and constantly changing problems, and delivers the correct answer at any desired instant. Although the gunner sights at the target itself, the computer aims the guns at the point where the target will be when they go into action.

Typical of several models is the sight developed by the Sperry Gyroscope Company for use with a hydraulically driven turret Looking like an ordinary small black box, it is mounted between the turret's two guns. At one end of the box are knobs similar to the tuning knobs on a radio. On its top is a reflecting glass—the scanning sight with two parallel lines of light which can be spread apart or drawn together by manual control or a foot pedal. These light lines are the governors of the range finder.

Before the take-off, the computer is set for the type of ammunition used and windage jump, or deflection to the right caused by the spin of the bullet. After the take-off, another adjustment is made to compensate for the plane's speed. A power switch takes the manual labor out of the gunner's job by making the turret swing automatically in accordance with the "orders" from the sight.

The gunner has a pair of handle bars with firing buttons at his finger tips. When he spots an enemy plane approaching, he identifies it by type and sets a master knob on the sight at the plane's approximate wing spread. A Messerschmitt, for example, with a wing spread of about 33 feet, will call for a setting at that figure. Swinging the turret until the oncoming target is framed in his reflecting glass, the gunner brings the light lines to their minimum spread, which is governed by the master knob setting when he identified the enemy plane. Since

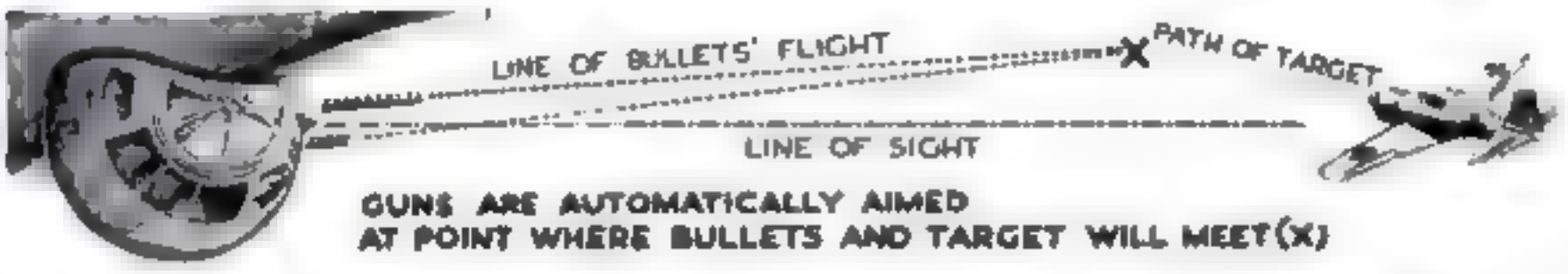
HOW SIGHT DOES WHAT NO HUMAN MIND CAN



ANGULAR RATE, measured in degrees per second, is the speed at which the turret must be rotated in order to keep the guns on target

LEAD IS COMPUTED by multiplying the angular rate by the time it will take the bullet to reach a given range. To this figure must be added the distance that the bullet will be deflected by windage as well as the distance that its spinning through the air will cause it to "jump" to the right. This is all done by the computer in a split second. All the gunner has to do is to track the plane and press the firing buttons

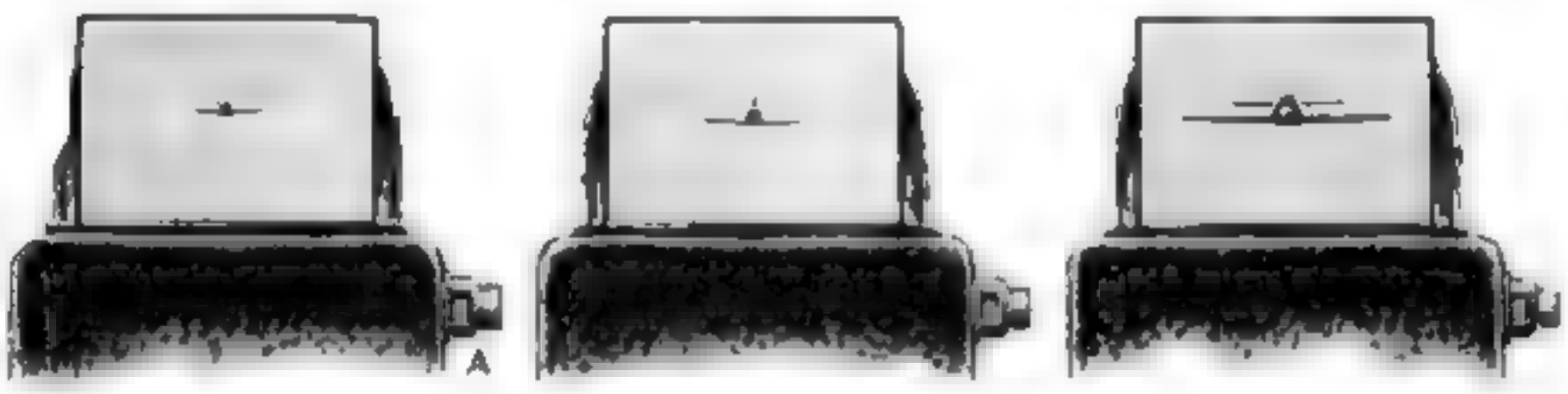
HOW COMPUTER GETS THE INFORMATION THAT IT NEEDS



GUNS ARE AUTOMATICALLY AIMED AT POINT WHERE BULLETS AND TARGET WILL MEET (X)

The speed at which gunner rotates turret in order to track plane gives automatic gunsight angular rate. Distance of plane (see below) gives sight the time of bullet's flight. With correction previously set for windage and "jump," gunsight now has all information necessary for computing lead

SCANNING SIGHT TELLS THE DISTANCE OF ENEMY PLANE



1 As soon as he identifies the enemy plane, the gunner sets the master knob for the plane's approximate wing spread. He then brings the reticules as close together as setting will allow

2 When the approaching plane fills the space between the lines, the gunner knows that it is within effective range, and that he can start tracking and pressing his firing buttons

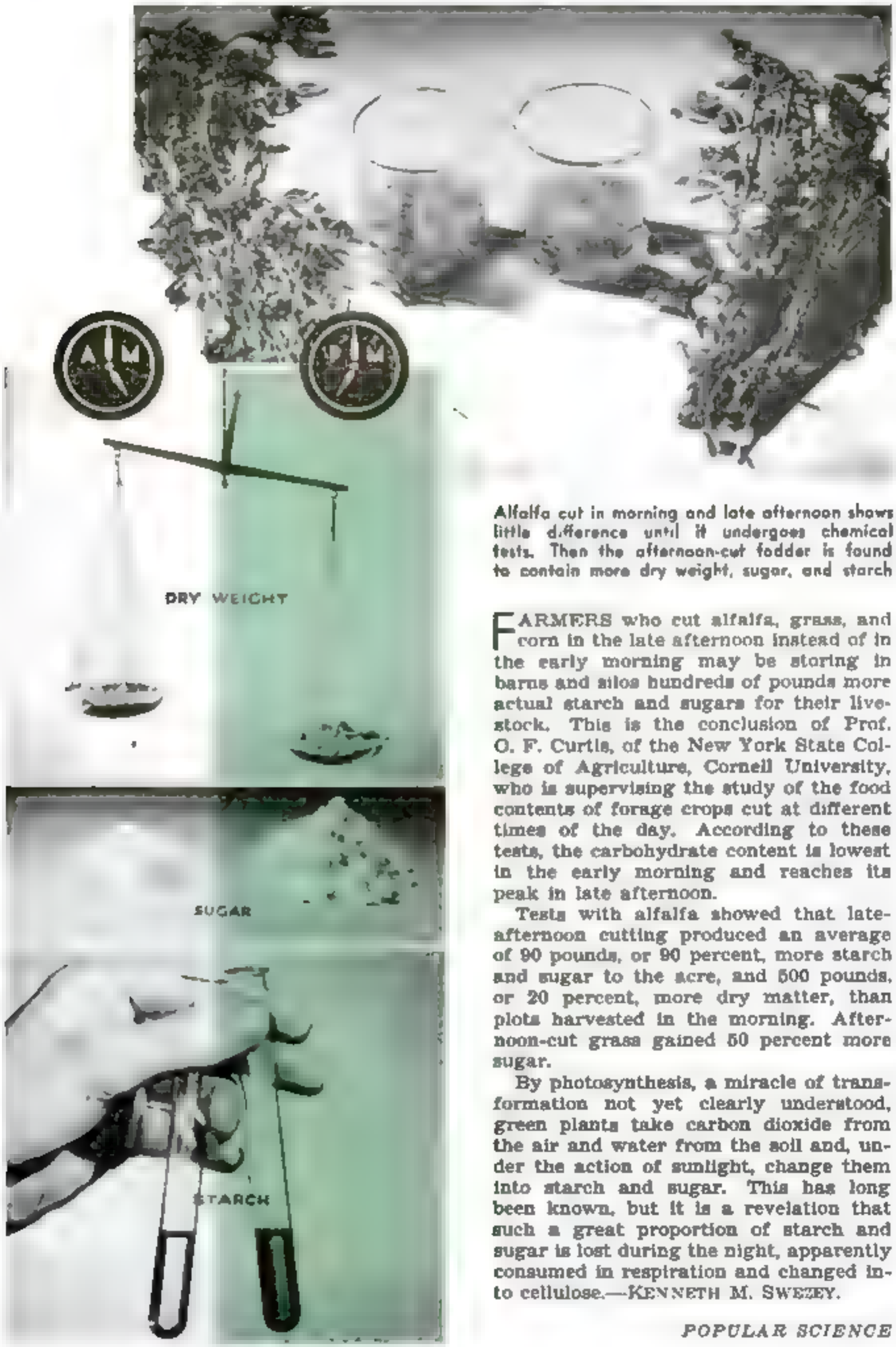
3 As the plane grows larger in the sight, the gunner moves the lines apart so that they always just enclose the plane. In this way he keeps gunsight "informed" of the plane's distance

the over-all dimensions of a fighter are approximately the same from any angle, he has only to keep the plane between the light lines, and as soon as the target fills the space between the lines it is within range. At that point, the gunner can begin effective fire, and can continue it as long as the light lines enclose the approaching plane's extremities.

Everything has been compensated for automatically—range, speed, windage, deflection, and angular rate. All he has to do is track the plane, and press the firing buttons.

All American medium and heavy bombers are now equipped with automatic computing sights and power turrets of one type or another. This accounts for the lopsided scores when bombers go out and run into fighter opposition. Neither the Japs nor the Germans have power turrets or computing sights, and, considering the development necessary to bring them to perfection and the precision work needed to manufacture them, it is unlikely that the Axis will produce such a sight unless the war drags on considerably longer than now seems likely.

Make Hay While the Sun SETS!



Alfalfa cut in morning and late afternoon shows little difference until it undergoes chemical tests. Then the afternoon-cut fodder is found to contain more dry weight, sugar, and starch

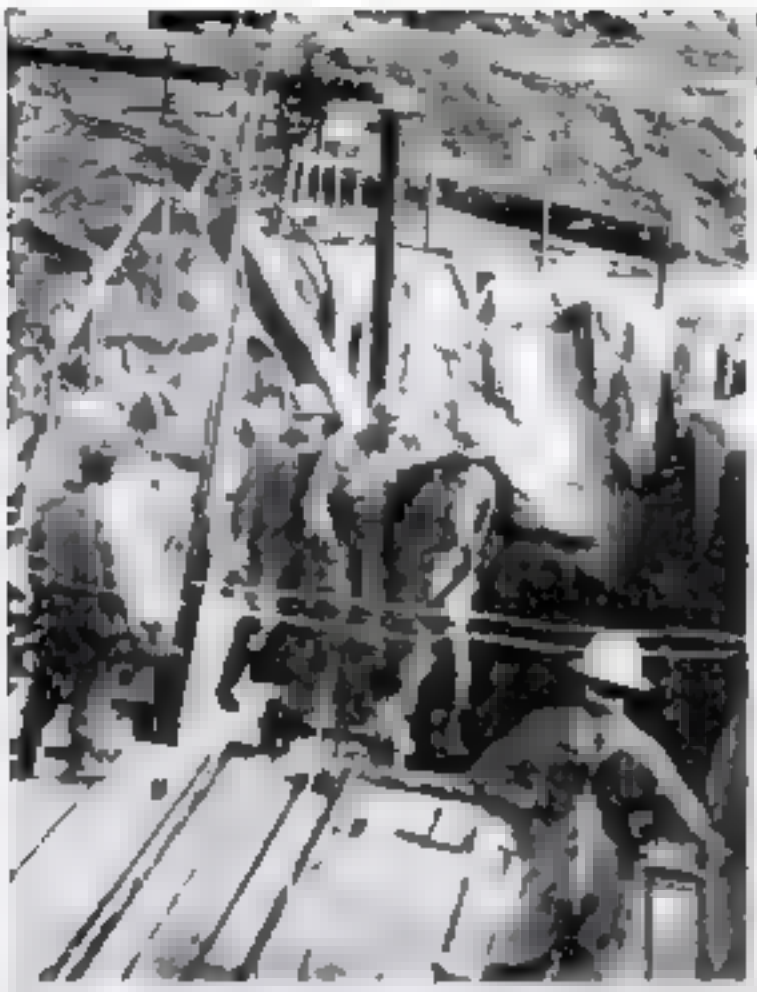
FARMERS who cut alfalfa, grass, and corn in the late afternoon instead of in the early morning may be storing in barns and silos hundreds of pounds more actual starch and sugars for their livestock. This is the conclusion of Prof. O. F. Curtis, of the New York State College of Agriculture, Cornell University, who is supervising the study of the food contents of forage crops cut at different times of the day. According to these tests, the carbohydrate content is lowest in the early morning and reaches its peak in late afternoon.

Tests with alfalfa showed that late-afternoon cutting produced an average of 90 pounds, or 90 percent, more starch and sugar to the acre, and 500 pounds, or 20 percent, more dry matter, than plots harvested in the morning. Afternoon-cut grass gained 50 percent more sugar.

By photosynthesis, a miracle of transformation not yet clearly understood, green plants take carbon dioxide from the air and water from the soil and, under the action of sunlight, change them into starch and sugar. This has long been known, but it is a revelation that such a great proportion of starch and sugar is lost during the night, apparently consumed in respiration and changed into cellulose.—KENNETH M. SWEZEY.

POPULAR SCIENCE

River Takes a Detour To Bare Iron-Ore Bed

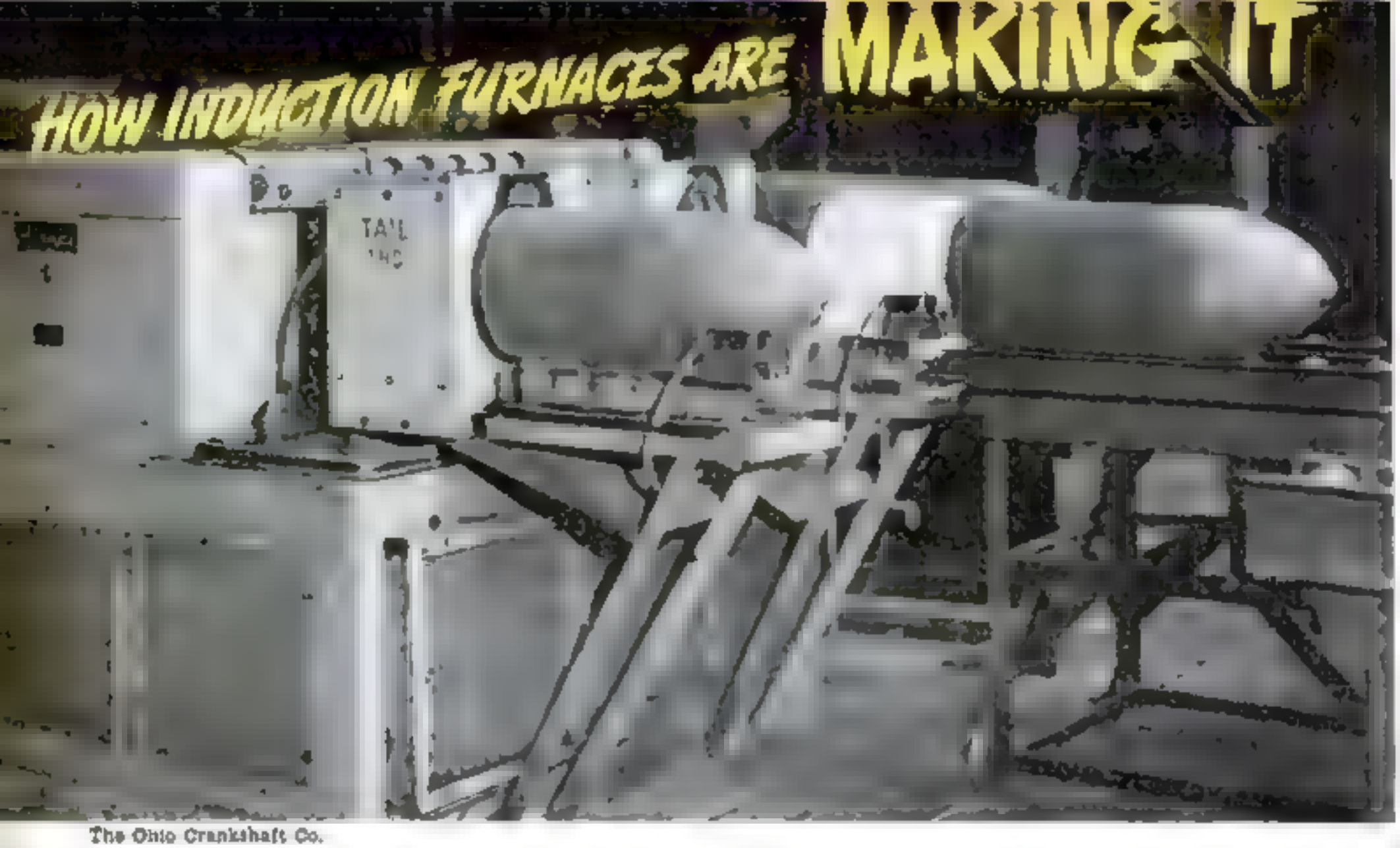


A 1,300-foot rock tunnel drilled low into Finlayson Lake is draining it slowly so as not to flood the lower countryside

With a diamond drill, engineers probed 40 feet below lake bottom to find the ore first detected by electrical instruments

BIGGEST drainage job in North American mining history is uncovering iron-ore deposits under Canada's Steeprock Lake, into which flows the Seine River. By raising the dam at the lake's inlet, making cuts between the higher Marmion and Finlayson lakes, and opening a drain tunnel into the bottom of the latter, the Seine has been directed into a new course. Pumps are now emptying Steeprock Lake.

HOW INDUCTION FURNACES ARE MAKING IT



The Ohio Crankshaft Co.

These 500-pound-bomb casings are being induction-heated prior to the process of tail spinning. Note the absence of handling tongs, made possible by the unusual localization in this type of heating. The ends of these casings can be heated to 2,000 degrees F. in just about three minutes and 15 seconds

By JACK O'BRINE

WAR industry is "cooking" with electricity these days. At almost any plant where the application of heat enters into metal processing, you'll find an induction furnace doing the job. Its magic coil is taking the place of fire to produce record-breaking quantities of fighting equipment. Improved cannon, armor-piercing shells, parts for tanks, planes, and submarines, and a great miscellany of war tools come magically from it.

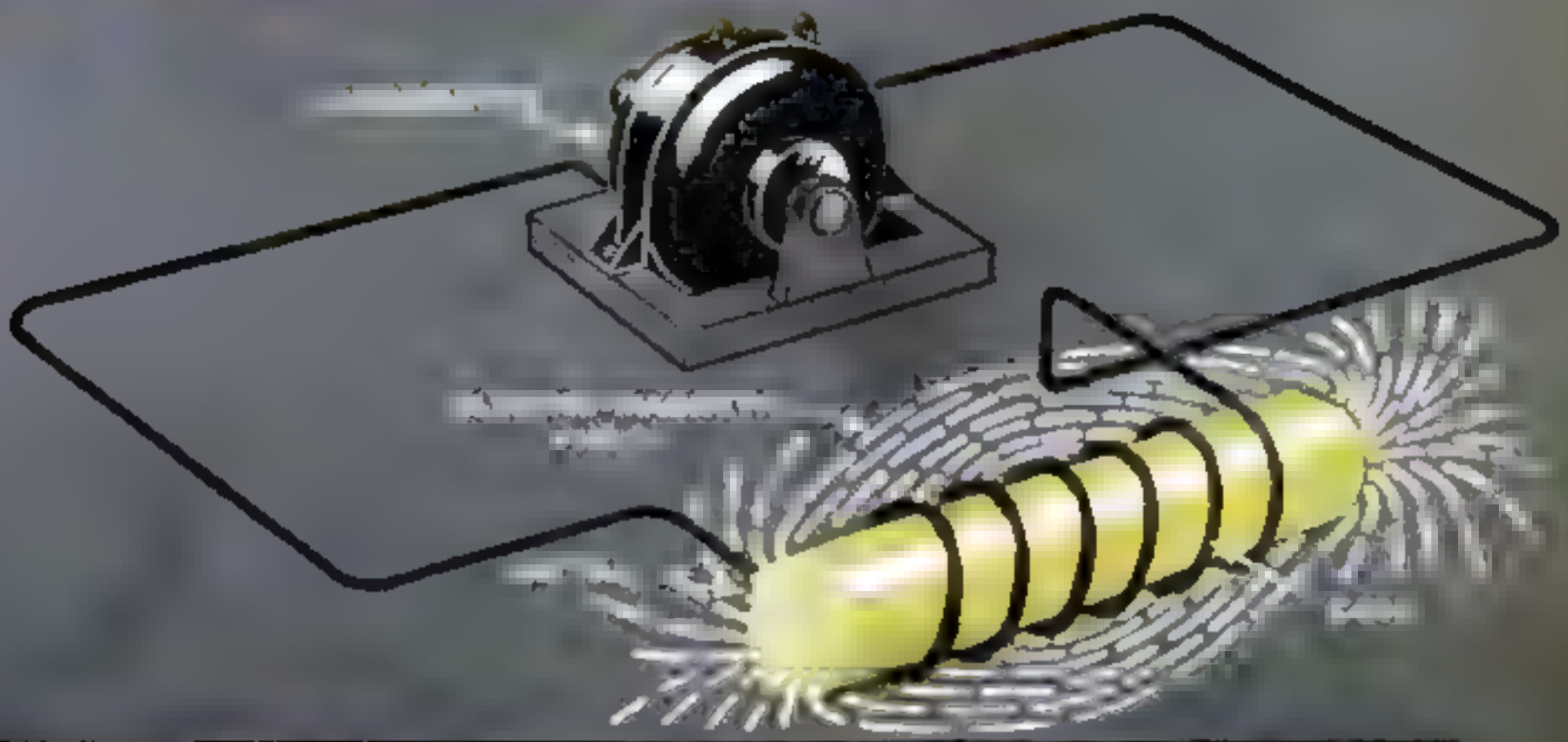
On the civilian front, too, induction heating works like a Turk. It's far more useful than most of us realize. Nearly every time we shave with a sharp razor blade, get fine music from a long-lasting phonograph needle, plug in our radio, or do an exceptional job in our home workshop with good tools, we can thank an induction furnace. For, more than likely, it was used in melting, forging, brazing, case-hardening, welding, or soldering those items so perfectly.

This metallurgical master worker dates its success story from the last war. Edwin F. Northrup devised it as a means of speeding production. Though too late for use then, its debut attracted wide attention among American industrialists. Before 1942 our industry had installed induction heating equipment using 175,000,000 watts, and in that year war plants accounted for more installations than in any previous three-year period.

Northrup's basic principle still holds good, although furnaces themselves have undergone many refinements to attain production wizardry. It's the same principle that is used in an ordinary transformer. In fact, if you strip off the manifold mechanical gadgets from an induction furnace, you have little more than an insulated box built around a transformer whose core has been removed to make room for whatever metal you want to heat. Heating occurs almost instantaneously when you send an electric current through the transformer coil surrounding the metal to be treated. The induced voltage, encountering resistance in the metal, produces a power loss which appears as heat. By varying the frequency and strength of the current and the size of the coils, you can control the depth of heat penetration, the area affected by the heat, and the temperature. Just push a few buttons and you can give the metal any kind of treatment desired.

Engineers have compared induction heat with the radiant heat thrown off by the sun. When the sun's rays pass through space, there is slight loss of energy, and thus negligible heat is produced. But when they strike a dark body, its surface is heated. In like manner, high-frequency magnetic waves from the coil pass through all insulating ma-

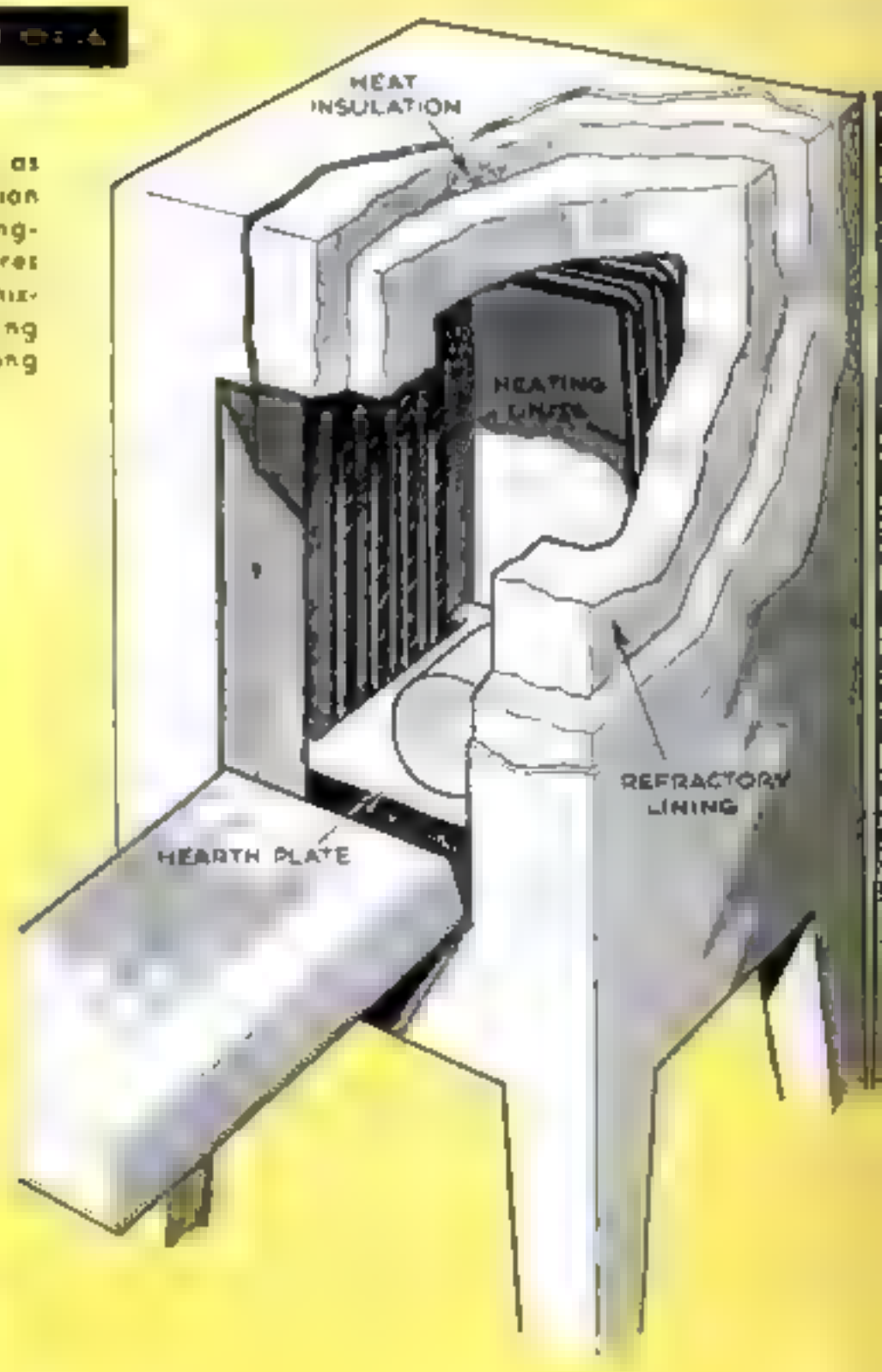
HOT FOR THE AXIS



THIS IS THE PRINCIPLE OF INDUCTION HEATING

HOW THE PRINCIPLE IS APPLIED

Hundreds of electric heat-treating furnaces, such as those shown below, are being used to harden precision parts required in planes and tanks. Made by Westinghouse these furnaces do their work at temperatures ranging between 1 500 and 2 000 degrees F. A gas mixture known as Endogas is introduced into the heating chamber to protect the work from scaling or softening



terials without dissipating their energies, yet create heat when they strike a metal body. Nonconducting materials which enter the magnetic field—intervening air, for example, or parts of the human body—are not affected. This explains why a man can place his hand within an induction furnace without suffering the slightest injury, though a piece of metal put there will soon be white-hot.

Induction furnaces now being used in the manufacture of so many of our weapons of war require an alternating current of high frequency. In that type of current, the magnetic lines of force change direction rapidly, threading the metal within the coil and setting up the current there that develops the heat. Direct current will not do the job.

In many installations, tubing is used instead of wire in the inductor coil. This is possible because of the "skin effect" characteristic of the alternating current, a tendency of the current to concentrate on the surface of the conductor, especially at high frequencies. Crowding of the current on the surface enables the induction furnace to attain remarkable results in hardening metals and gives it a "stirring effect" extremely valuable in melting operations. Because of it, shallow-layer objects, such as shell casings and crankshafts, can be heated so quickly that underlying portions are not affected, and alloys of homogeneous nature can be formed through thorough mixing.

Continuous furnaces—that is, relays of furnaces—have now been designed to meet needs in specialized industries. They are equipped with conveyors or mechanical carrying devices and have accurate time and temperature controls. Furnace ratings, depending on the particular operation, run anywhere from a few kilowatts to as many as 1,200 kilowatts. In some cases, engineers have designed ingenious mechanisms to handle materials entirely automatically.

Perfecting of protective atmospheres for use in the heating process is another step forward. By means of gases applied so as to surround metal parts, the operators are now able to prevent oxidation and decarbonization. The open-fire method of heat-treating never has been without possibility of distortion and chemical alteration of the metal, requiring lengthy and expensive sand-blasting, pickling, machining, and grinding operations after the treatment. Faster, better-controlled heating provided by the induction furnace saves time and money, since there are no blemishes or marring results. Equipment now available maintains a protective atmosphere in the furnace.

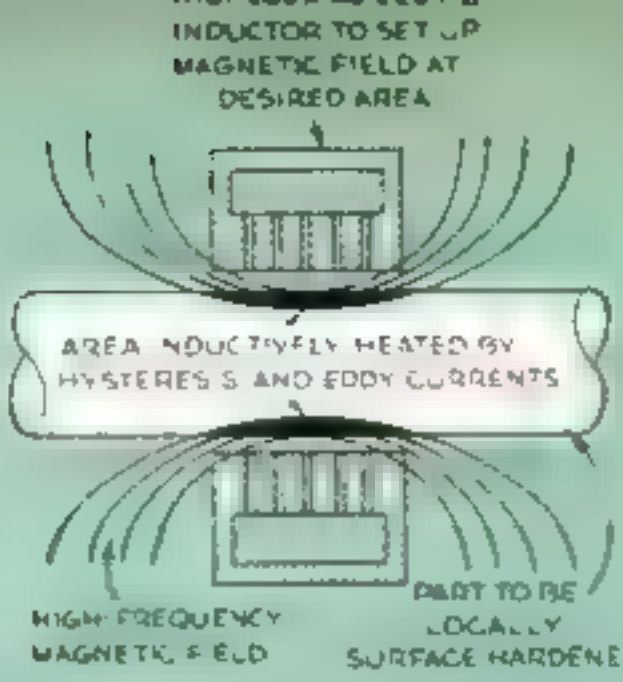
Induction heat often figures in the headlines these days from war-production lines. One of the most spectacular advances in gunsmithing—the centrifugal casting of gun barrels—is a direct outgrowth of research in this field. Traditionally, gun barrels have been fashioned laboriously from ingots, forged, heat-treated by conventional methods, and then machined into shape. But ordnance experts hit upon the idea of simplifying the process with the aid of electric furnaces. Widely used today is a process in which ingredients which make up steel for the barrel are melted in an induction furnace, where alloying is rapid and melting losses low. Metal is carried in the furnace itself, which doubles as a giant ladle, and is poured into a horizontally rotating mold. The mold is turned until the casting solidifies. Now, when you remove the barrel from the casting machine, you find it easy to finish.

Centrifugal forces have done the lion's share of the work. As the rotating occurs, the barrel has taken shape, not as a solid ingot requiring expensive hollow-forging or machining operations, but as one already having a hole through the center. Moreover, any slag particles or impurities present in the mold, being lighter than the steel through which they are dispersed, float to the bore. You can quickly get rid of them in the machining process.

Induction heating is particularly well suited for forming, brazing, and hardening operations in making projectiles. Its chief advantages are speed and uniformity of heating, ease in controlling heat to specific patterns, the metal's freedom from surface scale after treatment, and greatly improved working conditions for operators. Another consideration recognized by farsighted industrialists is the fact that induction-heating equipment can be turned to peacetime use without investment loss. Indeed, postwar plans have inspired many industrialists to put in electric furnaces. For instance, while a frequency of 1,000 cycles is sufficient for heating many weapons, most manufacturers have installed 2,000-cycle furnaces because they can be more readily converted to automotive work after the war.

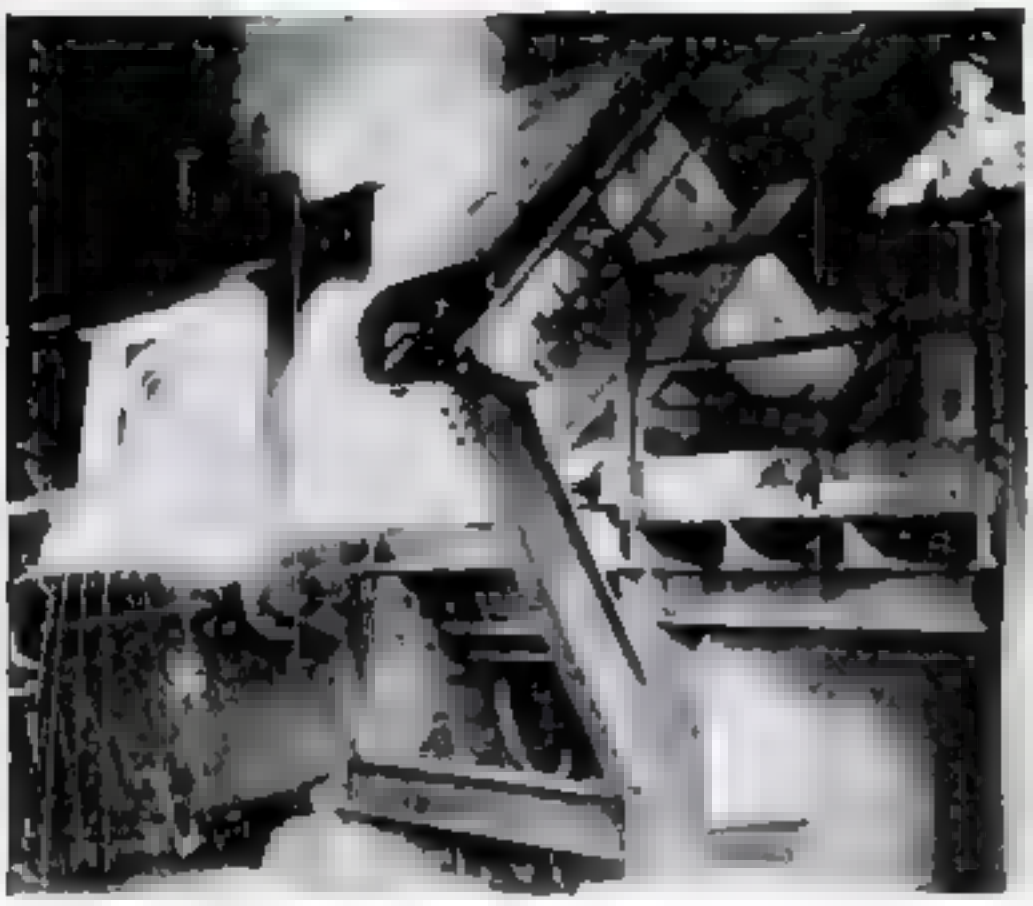
Great is the variety of tasks that induction furnaces perform. They are used to expand metal parts, or to shrink those parts for fitting; they treat the nichrome (nickel chromium) wire used in spark plugs, tune the tungsten contact points found in virtually all gas motors. Alnico magnet steel used in radio and meter parts is almost exclusively a product of induction heating. In radio and radio-control equipment, induction heating is used to drive off occluded gases from metal parts in sealing vacuum tubes. It's in nearly all Navy yards, Army ordnance plants, arsenals, and war plants where special alloys and castings are made. Every day they find new uses for this versatile furnace to put more heat on the Axis.

An induction machine heats the corner of a tool shank on which a tungsten-carbide tip is to be brazed



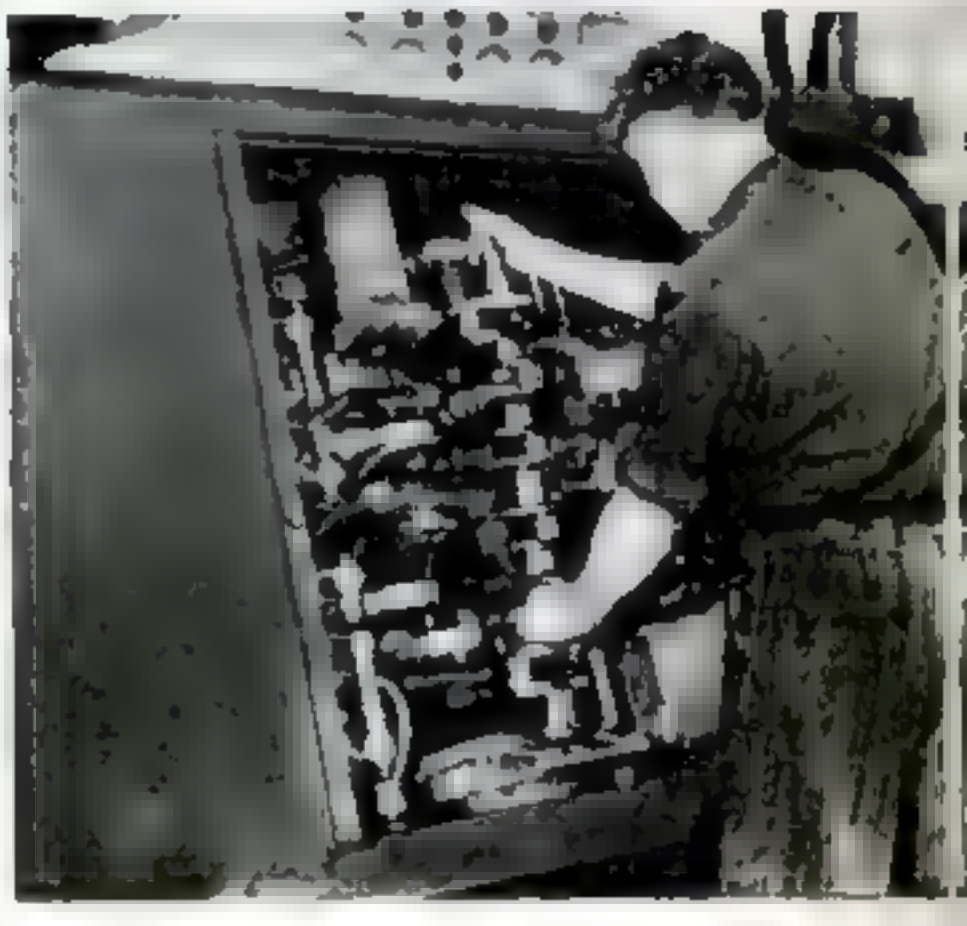
Induction heating can harden the teeth of a sprocket—and leave remainder unaffected

INDUCTION PUTS THE HEAT JUST WHERE IT IS NEEDED



Ajax Electrothermic Corp.

In compounding alloys, an electric furnace's electromagnetic forces automatically stir the ingredients, and thus aid the mixing. Melting is speeded up by concentrating the current into small charges



Here is another instance of how induction heating can restrict its effect to a given area. The crankshaft above is about to get a heat treatment that will harden only its bearing surfaces

An extra-long crankshaft is shown below being hardened in a machine that carries an inductor block for each bearing. By varying the size of the coils, as well as the power and frequency of the current (which, for all induction work, must be alternating), both the depth and degree of hardening can be accurately controlled

What You Should Know About

Propellers for Our Fighting

The modern aircraft propeller is an amazingly ingenious mechanism designed to get maximum efficiency of engine and plane.

By JAMES L. H. PECK

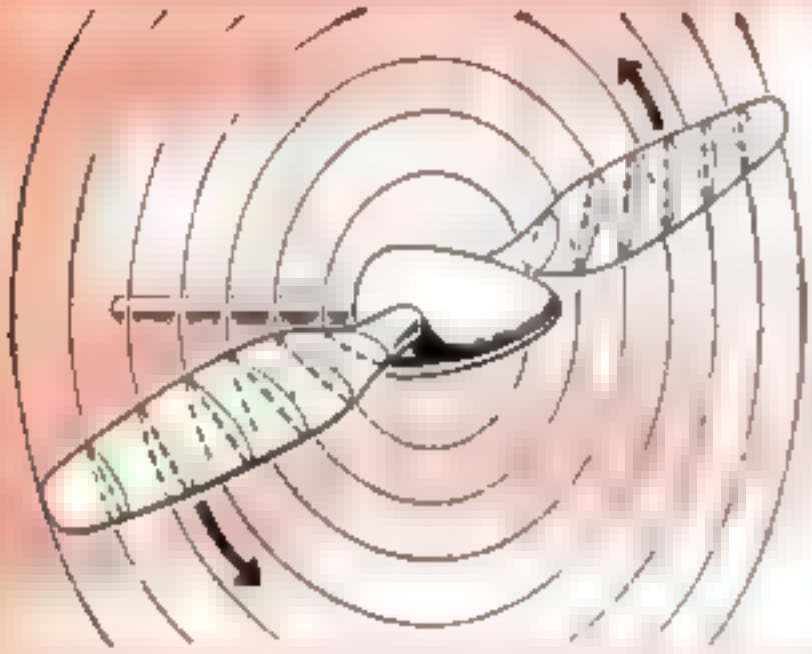
Drawings by STEWART ROUSE

AFTER a recent battle, American forces captured a German soldier who kept pointing upward and babbling about "big whirling swords." Some time later, doctors discovered the cause of his hallucinations. Lightning and Warhawk fighters had run interference for the Yank advance by carrying out one of their blistering strafing attacks at tree-top altitude. The Nazi had somehow escaped from his flaming tank and survived the assault; but, in his fear, he had psychologically identified the sunlit, spinning propeller blades of the low-sweeping planes as whirling swords.

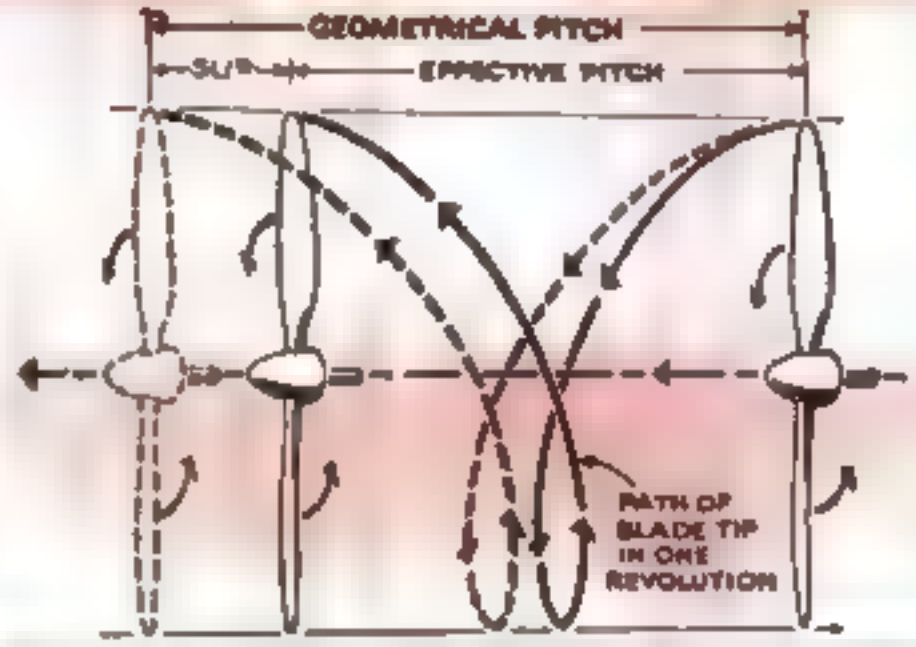
Indeed, in a more practical manner, the whirling prop blades of our warplanes do symbolize their deadliness. The propellers that pull our fighters and bombers—and those of our allies—through the skies over half a dozen war theaters are more than a little responsible for the superb performance that is affording American-made craft the air superiority they now enjoy. The prop is as much a part of the plane's power plant as is the engine. It translates the engine's power output into the "thrust" necessary for sustained flight.

If we consider the propeller as a screw working its way through the air and pulling the plane along—or pushing it along, if it is mounted aft of the engine, as in the case of

A PROPELLER BLADE IS A SPINNING WING. HERE'S WHAT



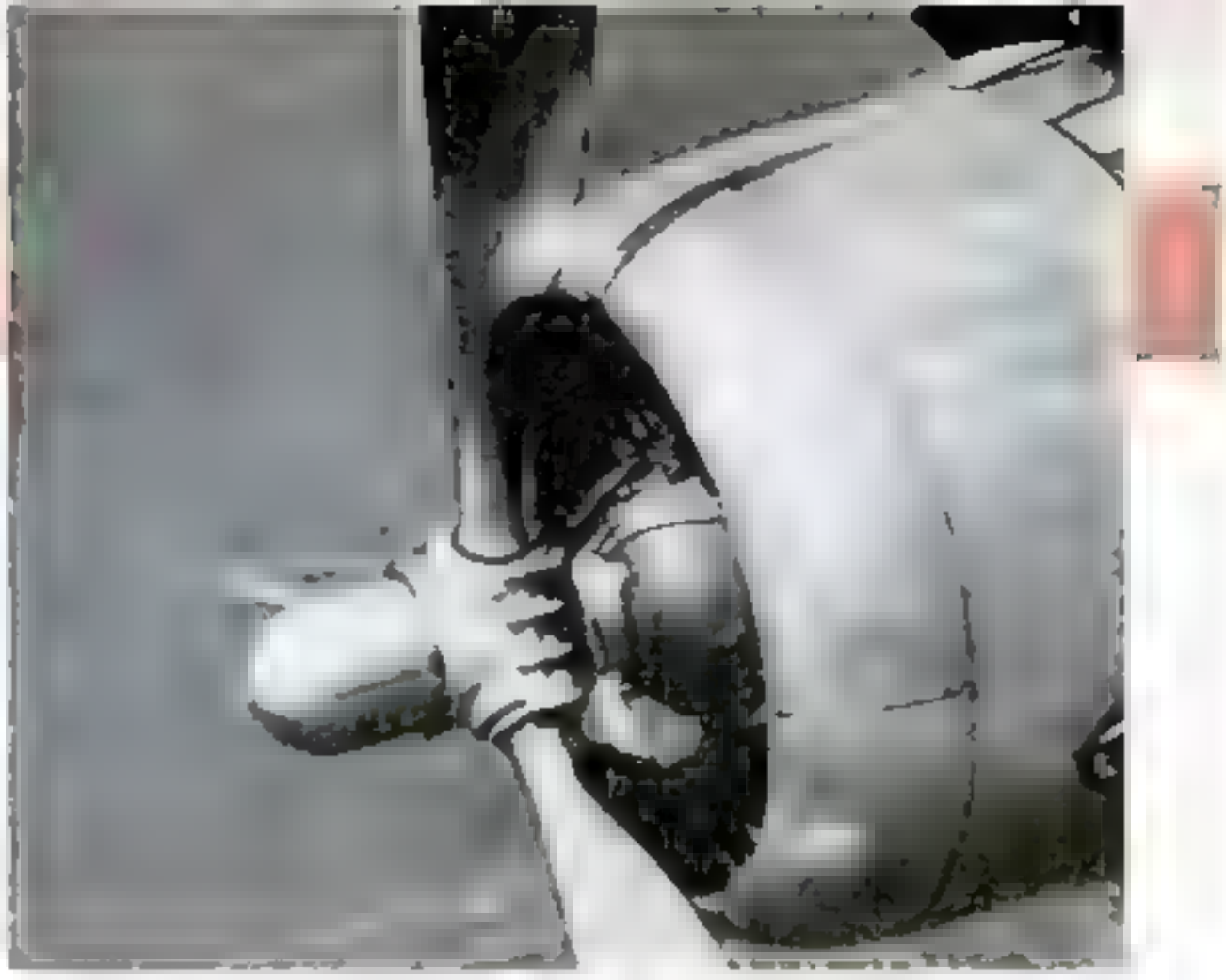
Essentially a set of spinning airfoils a propeller's blades are shaped like a plane's wings. However since the tips travel at a higher speed than parts nearer the hub the blade angle must be varied progressively, decreasing from the shank toward the tip



A wing gets its lift from the partial vacuum created above it, and from pressure below. Corresponding forces give a propeller its pull

Slip stream of a propeller is the equivalent of the downwash from a wing It takes the form of a corkscrew spiral of air which upsets steering equilibrium

Planes



Feathering keeps a dead engine from being damaged by "windmilling"

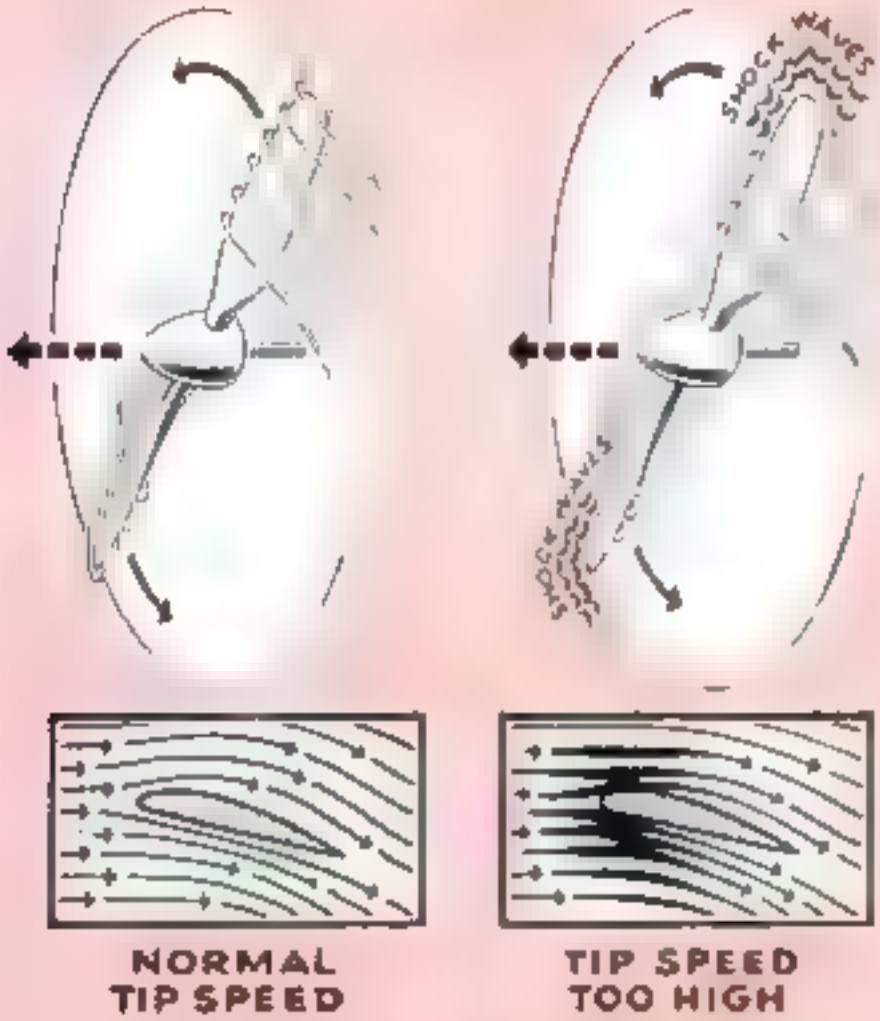
our Bell Airacuda and some of the new pusher-type fighters—just as a steel screw bores its way through a piece of wood, the principle of propulsion is reduced to its simplest terms. But, unlike the screw, which advances by pushing the rear face of its thread against the fibers of the wood, the prop advances by creating just ahead of its whirling blades an area of suction into which they are drawn The propeller blades are shaped exactly like the wing section of a plane and act on the same principle. The prop is, to all intents and purposes, a set of spinning airfoils.

Just as the airplane wing must move forward fast to maintain its lifting properties, the propeller must rotate swiftly in order to provide thrust. The faster it turns, the more thrust results—up to a certain point. And, just as the wing is tilted upward slightly in order to deflect the air downward (this setting is called "angle of attack"), the prop's blades are twisted so as to deflect the air rearward. This twist, or "blade angle," enables the blades to meet the air at an angle that is most favorable for thrusting efficiency.

In rotating, the tips of the propeller must travel around their greater radius within the same time that the prop hub completes a revolution. The tips, therefore, travel may times faster than the center of the prop. For this reason, the blades are not straight like a wing but twisted so as to permit the blades to meet the air at the optimum angle along the entire length of the propeller. The twist is most noticeable in the inner half of the blade. Within a foot or so of the hub, the blade merges from its flat shape into a round, thick section that provides no thrust whatsoever.

The very same laws of physics which permit a wing to lift or a propeller to thrust have decreed that we must pay a price for these aeronautical services. The steepest of these prices is drag. It is with drag that the propeller must struggle constantly as it pulls or pushes the plane through the air. Drag acts on the prop in the same way as on the wing, only more so because of the high speeds at which the prop rotates. Drag may be diminished by giving the wing section or prop blade a more streamlined shape. The new laminar-flow wing section—used

HAPPENS WHEN IT REVOLVES



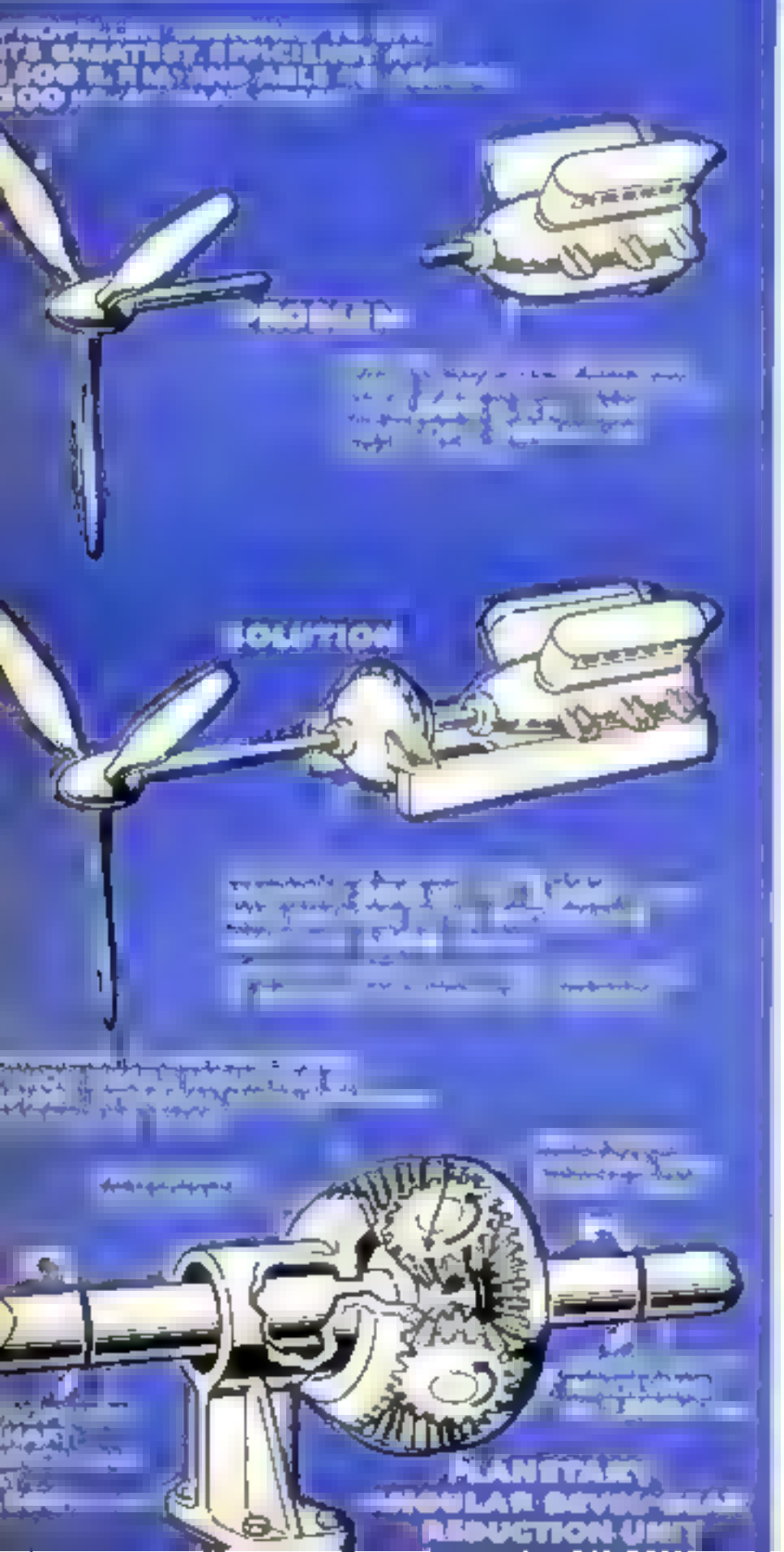
The faster the propeller turns, the more thrust it produces, until its tip speed approaches the velocity of sound (1,100 feet per second), where there is a sudden and overwhelming increase in drag. Pressure waves set up at the leading edge cannot get out of the way of the moving blade and must be dragged along. This phenomenon puts limits on length of blades and on propeller speed

GIVING PROP MORE POWER

With the use of more powerful engines, propellers must be adapted to absorb that power. The drawings at right show how engineers solve the problem, increasing blade surface while holding down length

MATING PROP TO ENGINE

Another difficulty arises from the fact that props and engines have different speeds for maximum efficiency. The answer to this is a reduction gear that enables the prop to turn at lower speed than engine

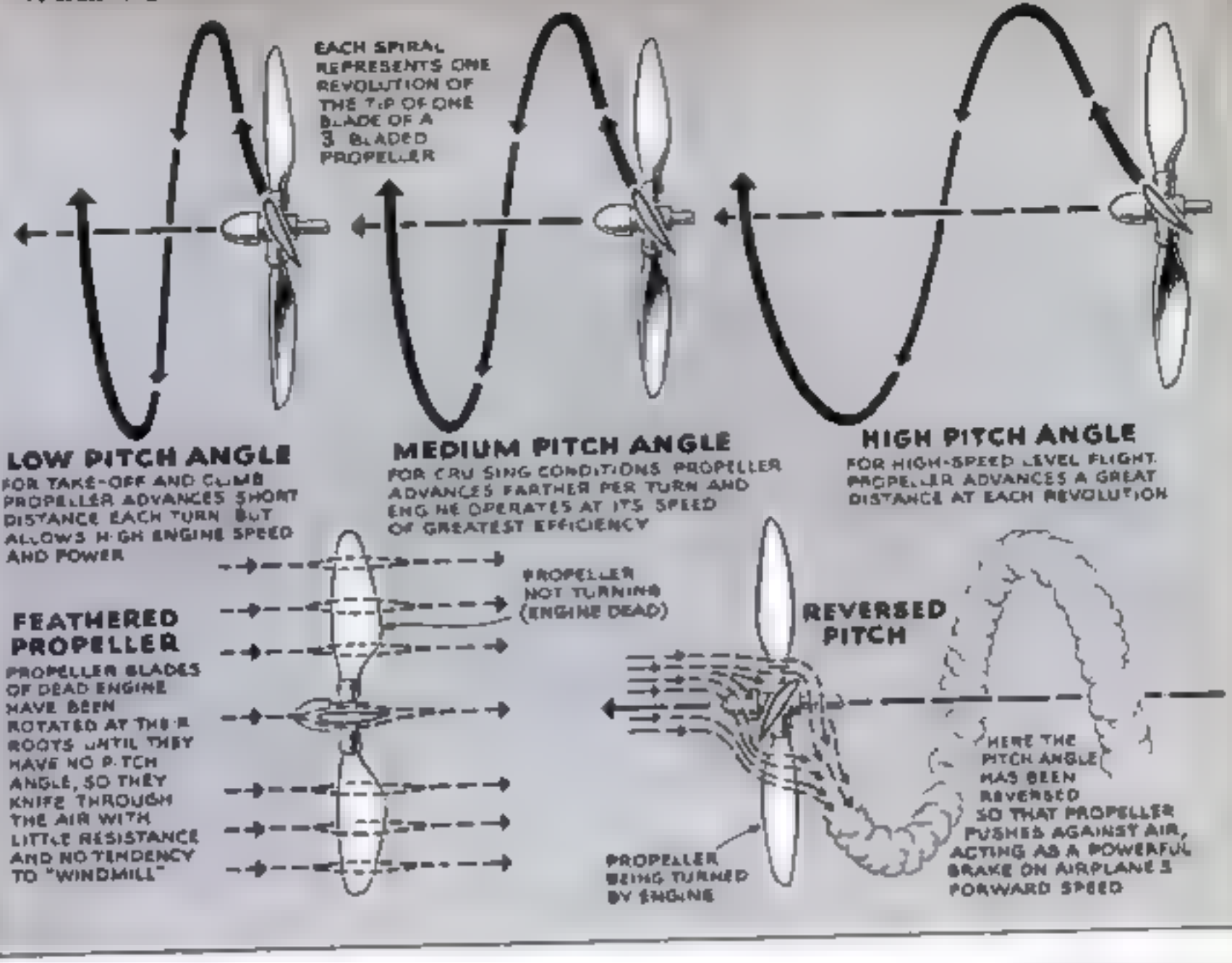


on the superb North American Mustang fighter-bomber and other American craft—has reduced drag almost 67 percent, and this same type of airfoil section is used by some of our propeller manufacturers.

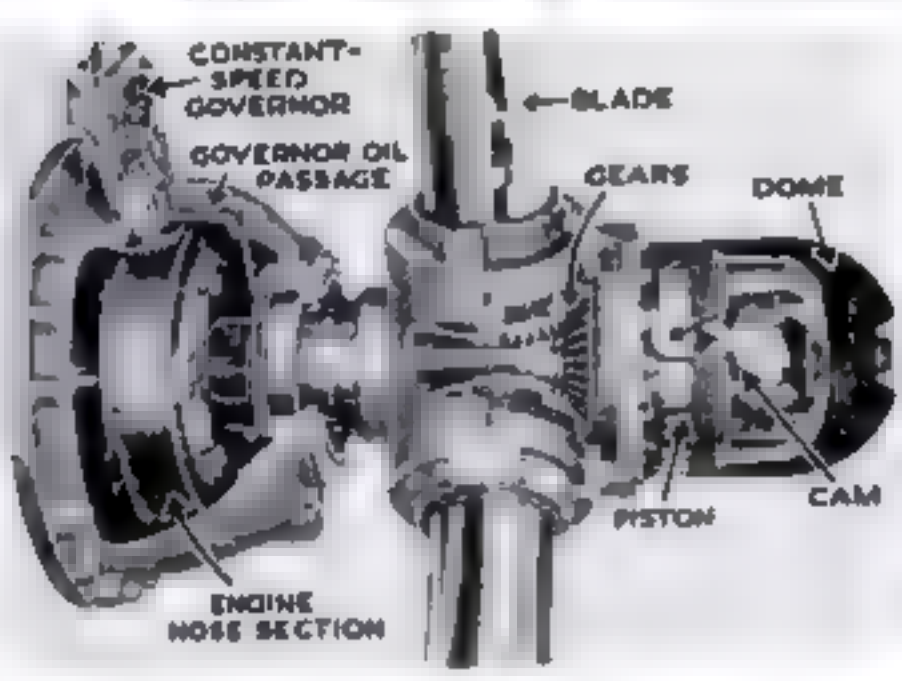
Greater efficiency may also be achieved by increasing the area of the blade to provide more thrust, but it is here that the engineers encounter trouble. The diameter of the propellers is limited by three considerations: on single-engined craft, the prop must be short enough to allow clearance when the ship is on the ground on level keel. On multiengined planes, ground clearance is not such an important factor because these ships are larger and sit higher, but using bigger props means moving the engines farther apart (and the outboard engines farther out on the wing). When these difficulties are overcome, there remains still another: the larger the propeller's diameter, the higher the tip speed. When the tips of the prop reach the speed of sound—1,100 feet per second—they become literally barnacled with a peculiar and exaggerated drag condition called a "shock wave." There are limitations on the width of the blades, too. As the blade is widened, it must be made heavier for structural reasons, and this results in greater drag and weight. Compromise is necessary for other reasons which have to do with more involved aerodynamic laws, and the product is the neatly tapered, knifelike propeller blade we see on today's warplanes and airliners.

Notwithstanding these difficulties, the propeller is just about the most efficient part of the airplane. How it got that way is somewhat of a story. Some of the earlier props

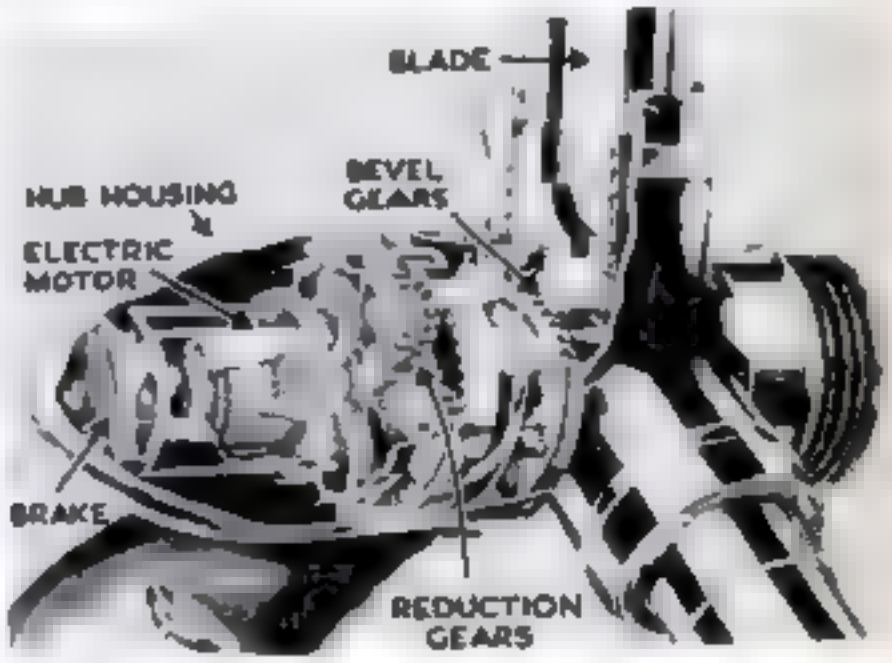
VARIABLE-PITCH PROPELLER HAS WIDE RANGE OF EFFICIENCY



HOW PITCH OF PROPELLER BLADES IS VARIED IN FLIGHT

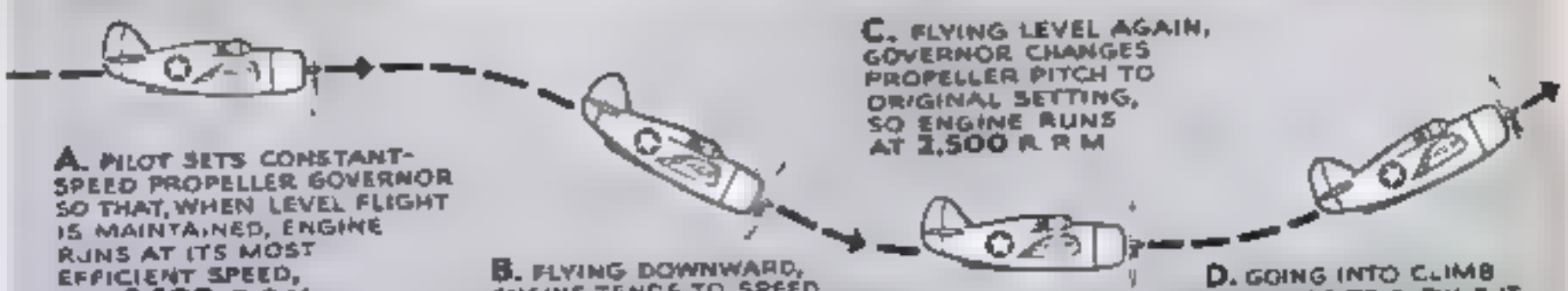


HYDRAULIC. In this Hamilton Standard Hydromatic hub mechanism, a piston moved by hydraulic pressure operates gearing and cams to increase or decrease the pitch of the blades. A governor maintains pressure balance for constant-speed operation



ELECTRIC The Curtiss Electric uses a motor to turn the blades through a set of planetary and bevel gears. A brake on the motor locks the blades in the desired position when current is off. Constant-speed operation is given by governor, switches

CONSTANT-SPEED PROPELLER KEEPS ENGINE AT MOST EFFICIENT SPEED



A. PILOT SETS CONSTANT-SPEED PROPELLER GOVERNOR SO THAT, WHEN LEVEL FLIGHT IS MAINTAINED, ENGINE RUNS AT ITS MOST EFFICIENT SPEED, SAY 2,500 R.P.M.

B. FLYING DOWNWARD, ENGINE TENDS TO SPEED UP, BUT GOVERNOR INCREASES PITCH OF BLADES SO THE PROPELLER ACTS AS A BRAKE ON THE ENGINE, KEEPING IT AT 2,500 R.P.M. THOUGH THE PLANE IS FLYING FASTER

C. FLYING LEVEL AGAIN, GOVERNOR CHANGES PROPELLER PITCH TO ORIGINAL SETTING, SO ENGINE RUNS AT 2,500 R.P.M.

D. GOING INTO CLIMB ENGINE TENDS TO SLOW, BUT GOVERNOR FLATTENS PITCH OF PROPELLER, MAKING IT EASIER TO TURN, SO ENGINE KEEPS ON RUNNING AT 2,500 R.P.M.

were nothing more than twisted airfoils, the blades being built up of wooden ribs and covered with cloth. Then they were hewn out of a solid piece of timber. The first really serviceable propellers were made of laminated wood; these proved reliable and aerodynamically efficient throughout the crucial years of aviation, and some of this type are still used for small civil planes and military trainers.

Early experiments with steel propellers were conducted in 1917, prompted by maintenance difficulties in World War I. During the next two years, several hollow steel props were tested by the Army Air Corps, and one solid steel model performed satisfactorily. In 1921, earnest development of the aluminum-alloy blade was undertaken, and the ease of making blades from solid stock, as compared with the expense of fabricating hollow steel blades by the then available methods, made aluminum more desirable. These dural blades and hubs gained wide popularity, and the steel-prop development lagged.

The improvement in performance and durability brought metal propellers into almost universal use during the late 20's; the most famous of these were the Hamilton Standard and Curtiss Reed, both made of dural. These props, of course, had a fixed blade angle, or pitch. As long as aircraft engines remained in the 500-horsepower bracket and 160 miles per hour was considered a lot of speed, the fixed-pitch propeller was adequate. As engines became more powerful and the demands for performance increased, power-plant limitations were relieved by the introduction of the adjustable-pitch prop, whose blades could be set to low or high pitch—or a happy medium—and clamped securely in the hub. In low pitch, the plane had fine take-off and climbing characteristics but was short on speed: in high pitch, with the blades turned to meet the air at a greater angle, the plane developed maximum speed but its take-off and climbing ability was not what it might have been. A compromise setting, however, gave the craft good all-around performance.

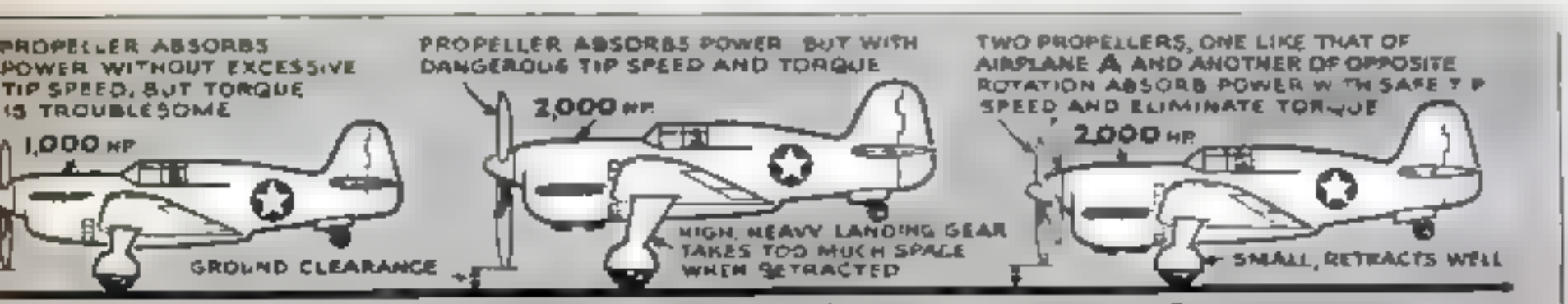
NEUTRALIZING TORQUE. The simplest way to counteract this turning effect on the plane is, of course, to have two engines with props rotating in opposite directions, as in the P-38

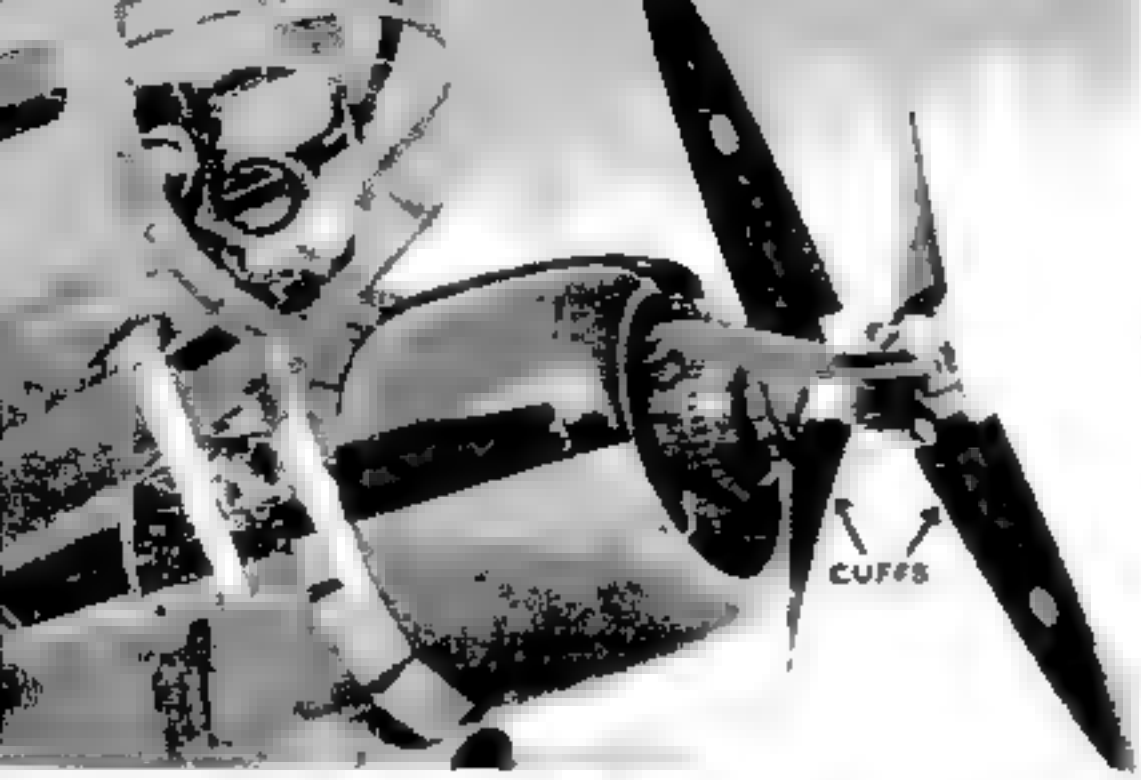
As the pioneers had pointed out many years before, what the flyer really needed was a propeller whose pitch settings could be changed during flight. In 1933, the Collier Trophy was awarded to Hamilton Standard for the development of a successful controllable-pitch propeller whose blades could be set at high or low hydraulically through a control in the cockpit that actuated the hub mechanism. During the same year, Curtiss perfected an electrically controlled propeller. By taking off with the prop blades in low pitch, flyers got their ships off the ground in 35 percent of the distance formerly required and increased their rate of climb approximately 30 percent. When they reached the desired altitude, the shift was made to high pitch, with the result that top speed was increased almost 15 percent. For higher flights, an additional 20-percent increase in the plane's service ceiling was obtained. The ingenuity of Hamilton Standard and Curtiss-Wright engineers greatly influenced airplane and engine design by making possible the use of larger and faster military craft and transports. The Lycoming-Smith electric controllable-speed prop became popular for lower-powered civil airplanes

But with the advent of 1,000-horsepower engines, this business of changing blade pitch required further refinement. The engine and prop have to be carefully mated: for maximum performance, each has to

DUAL-ROTATION PROPS PERMIT MORE POWER FOR FIGHTERS

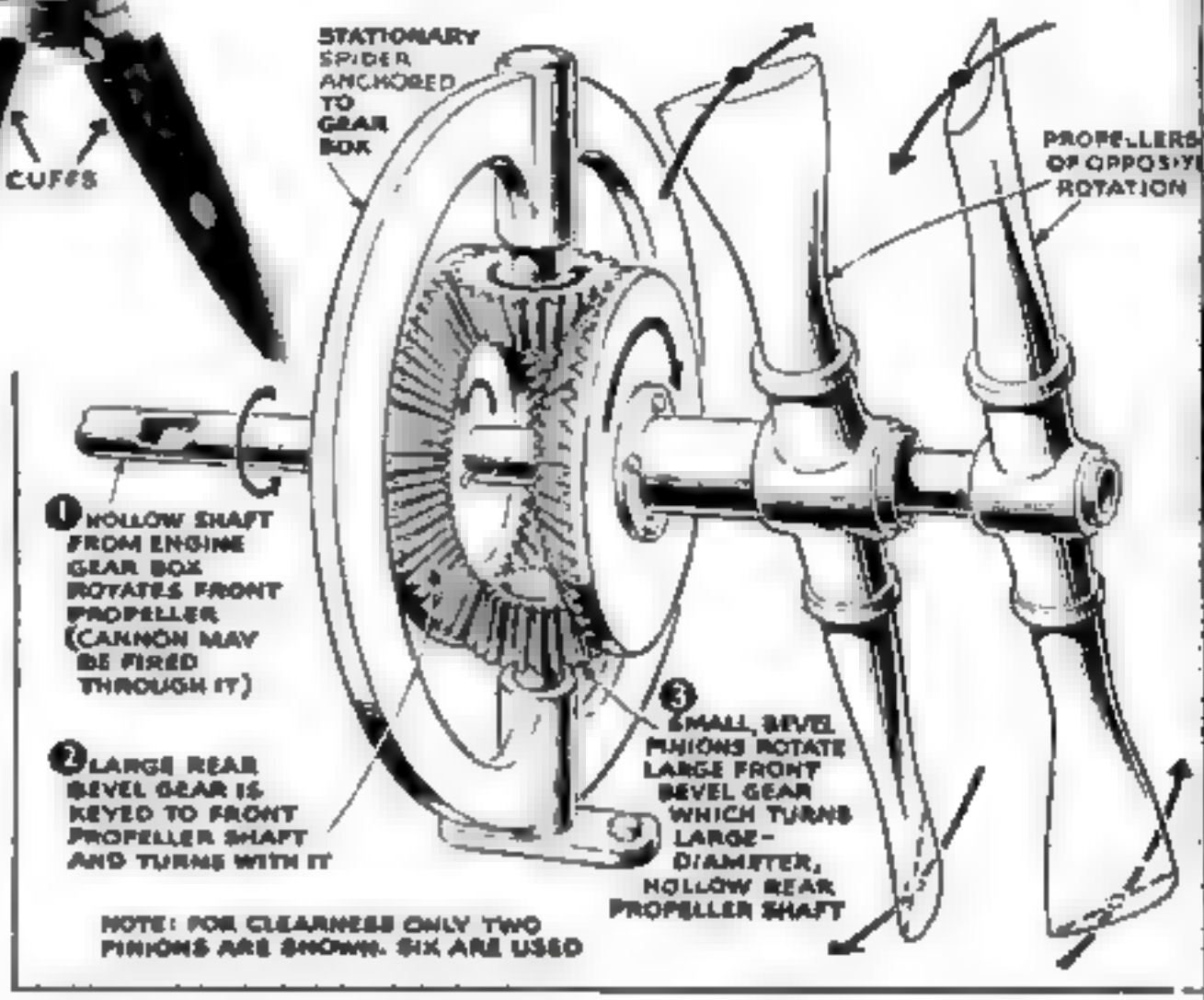
Suppose you were a designer and had the task of adapting an existing fighter type to use an engine of greater power. It would be easy to increase the size of the plane, but a single propeller large enough to absorb the extra power would require a higher landing gear, and its tip speed would be dangerously high. Also, torque would be troublesome. A dual-rotation prop solves these problems





DUAL ROTATION

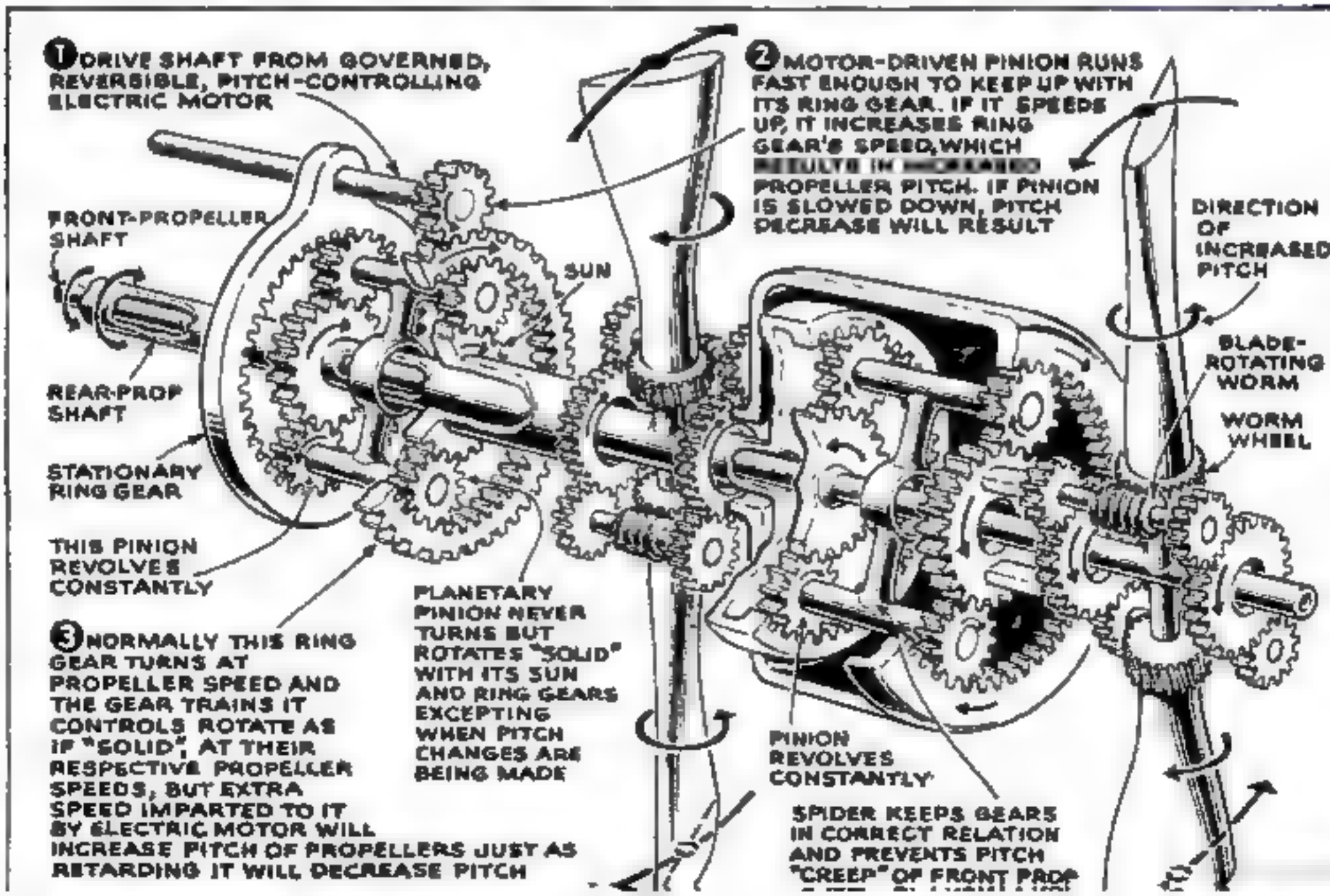
Ultimate in props today is the dual-rotation job of four or six blades, consisting of two units on coaxial shafts which turn in opposite directions. At the left is a Hamilton Standard Hydromatic installation on a Douglas B-23 medium bomber. The small knob behind the near blade tip is the constant-speed governor. Simplified drawing shows how prop works



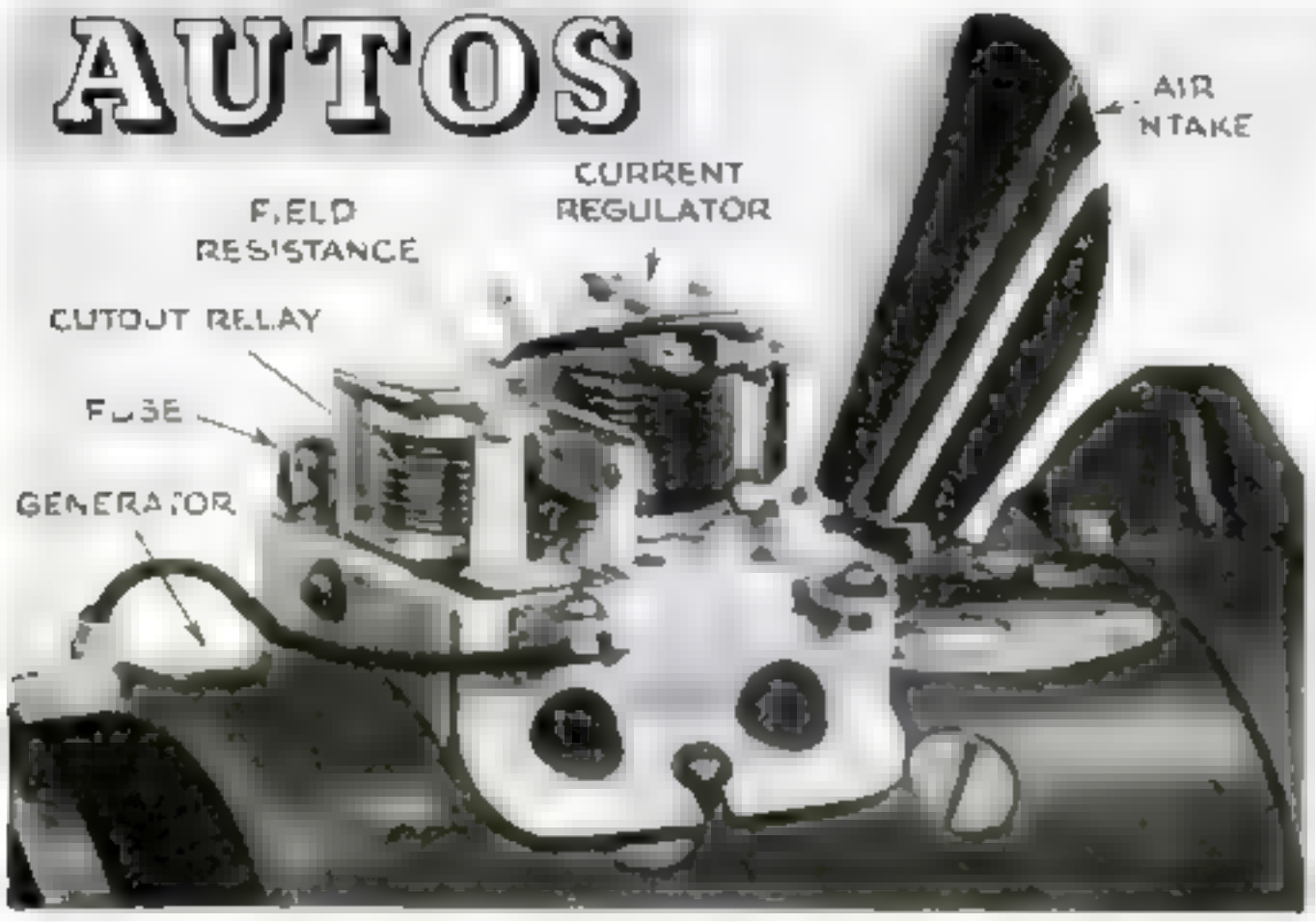
make concessions to the other, and for every combination of engine and propeller there is an optimum speed for the two. The engine's top power output is gained at a constant r.p.m., or crankshaft speed. This is generally higher than the propeller's optimum speed, and reduction gears are set into the engine nose section to slow down the prop to three quarters or half the engine speed.

In its job of translating the engine's horsepower into useful thrust, the prop also acts as a brake on the engine. But this braking effect must be carefully controlled or the engine will not function at its best. The two-position propeller is not sufficiently flexible in its operation to absorb the output of today's high-powered, highly super- *(Continued on page 212)*

VARYING PITCH ON AN ELECTRIC DUAL-ROTATION PROP



Keying Your Generator



Sensitive relays for governing the output of the generator are the electrical nerve centers of a car. At the left is pictured a two-unit type. The air scoop is part of the air-cooling system of the generator.

By RALPH ROGERS

GASOLINE rationing has in many cases taxed the capacities of automobile electrical systems to the utmost. Modern generator regulators are ingeniously designed to maintain, so far as possible, a full battery charge under all circumstances of car use. But when under rationing a car is not used sufficiently, even the flexibility of these devices may not be adequate to keep a battery from becoming discharged. Hence in some instances it is desirable to change the regulator adjustments somewhat to compensate for rationed driving.

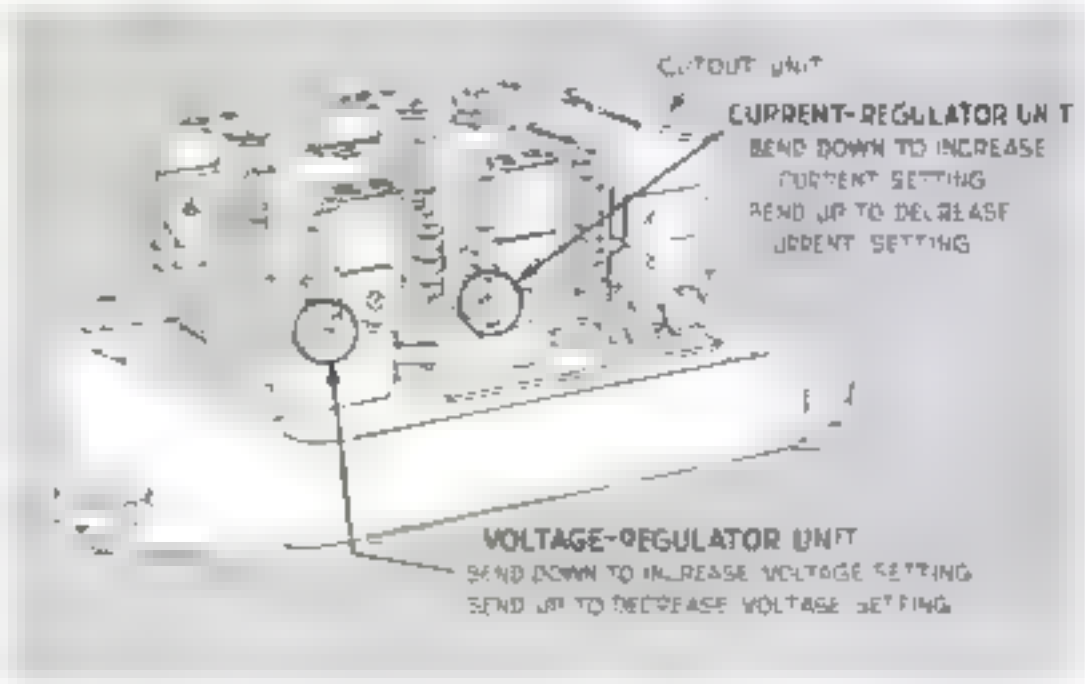
About a decade ago, before defrosters, radios, heaters, and other electrical accessories were in general use, the low-output, third-brush generator provided ample current to meet the ignition and lighting requirements of the average automobile. With this type of generator, it was a simple matter to adjust electrical output. By moving the third brush in the direction of armature rotation, output was increased; by moving it against rotation, output was decreased.

To carry the additional load imposed both by numerous accessories and by more powerful lighting and ignition systems, the generator output in more recent cars has been greatly increased. This has necessitated the use of additional means to control the generator and thereby protect the battery and lighting system.

Today, most passenger-car generators are controlled by a three-unit regulator which consists of a cutout relay, a current-limiting device, and a voltage-limiting device. However, a few cars are equipped with a two-unit regulator consisting of a cutout relay and a voltage-limiting device; control of the current is provided by a fixed third brush on the generator which flattens out the curve of current output. The operation of the two units in this kind of regulator is the same as that of the corresponding parts in the three-unit type.

The function of the cutout relay, of

The way to make current and voltage adjustments on a common regulator is shown below. Bend one spring hanger at a time



Output to Rationed Driving

course, is to disconnect the generator from the battery when the generator output is insufficient to charge the battery. The other two regulators provide control over the generator output under varying conditions of generator speed, electrical load, and battery charge. Each of the three units is, in effect, a magnetic switch. The cutout closes and opens the main charging circuit as motor speed increases and decreases. (Without the cutout, battery current would drain back through the generator when the motor is idling.)

The current regulator opens and closes the field circuit, rapidly inserting and removing resistance, when the generator has reached its maximum rated output. The voltage regulator also inserts and removes resistance in the field circuit when the voltage of the system reaches its safe maximum, thus preventing battery overcharge and excessive voltage.

Before you change any adjustments on the regulator, first make an inspection of the electrical system. Check the condition of the battery and see that the generator drive belt has the proper tension. Examine the generator for worn or sticking brushes, dirty commutator, defective field coils or armature, a grounded brush-holder, or weak brush springs.

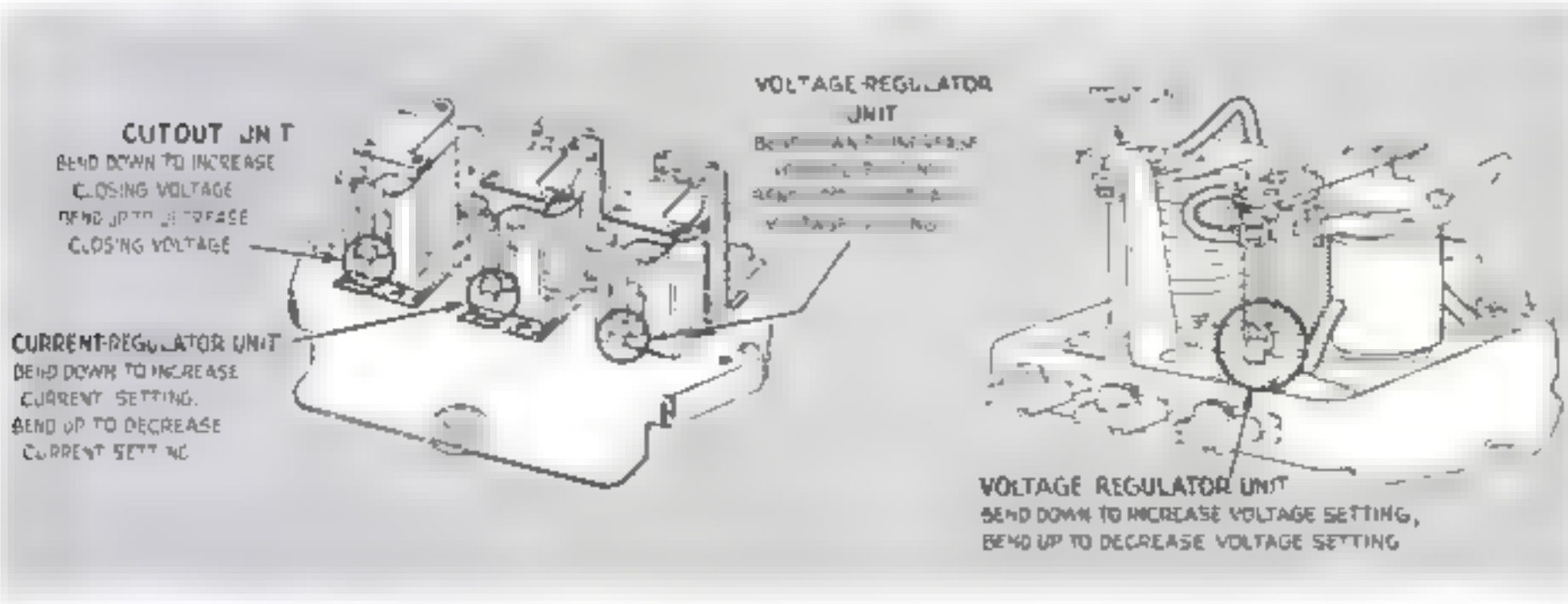
As a rule, the settings of a generator regulator will seldom change much during operation, although some variation may be caused by point wear, vibration, and temperature changes. The settings may sometimes need readjustment to compensate for some unusual condition of operation. For example, in semitropical climates, the voltage-regulator setting may have to be lowered somewhat, since a warm battery has a lesser resistance to current than a cold one.

With batteries handicapped by rationed driving, one common servicing job these days is to check on the efficient operation of regulators. The three drawings on this and the facing page show how to adjust common types of regulators. Because a regulator is a complicated and sensitive device, it isn't wise to change the settings yourself unless the need is clear-cut and no automotive electrician is available. Do not increase the current regulator setting to more than the rated generator output (which is obtainable from the manufacturer's data sheet if it is not stamped on the generator), because serious damage may result. Remember also that a slight bending of the spring clips will result in a substantial difference in regulator performance. An accurate ammeter and voltmeter are essential to precision adjustments; the dashboard meter will not do.

In servicing a regulator, there are also some specific rules to bear in mind:

1. Each type of regulator has been de-

Another typical three-unit regulator is shown at the left. The regulator at the right, which has no current-control unit, is used with a third-brush generator having a relatively constant current output



signed to operate with a particular generator and polarity system. For this reason regulators or relays must never be replaced by others of a different type or model. The only exception to this occurs when the manufacturer supersedes one model with another. If a regulator with the wrong polarity is installed, the result may be a rapid failure of the regulator.

2. Do not close the points on the cutout relay by hand when the battery is connected. To do so will damage the relay points, and by welding them together may cause serious damage to the generator.

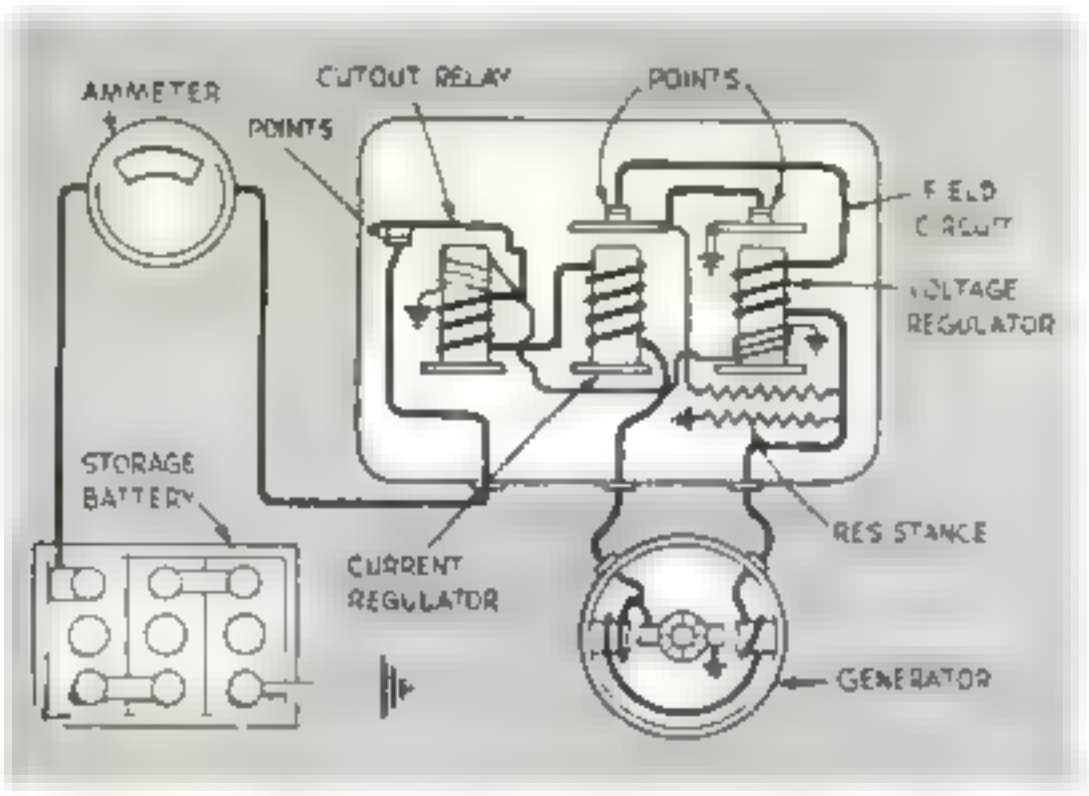
3. A regulator should be at its normal operating temperature when tests are made. If it has been demounted for service, it should also be tested in its normal operating position.

4. After any voltage-regulator adjustment, go through the following procedure before testing the new setting. Replace the cover and reduce the generator speed until the cutout points open; then speed up the motor until high output is achieved.

5. When any adjustment has been made on a regulator, the generator must be repolarized by momentarily connecting a jumper lead around the regulator. This permits a brief surge of current to flow from the battery to the generator. A generator with reversed polarity will cause arcing and burning at the points.

6. If the regulator points need cleaning, use a thin, flat, fine-cut file. Cavities not deep enough to make replacement of the points necessary may be scraped with a spoon file or riffler. The points should then be cleaned with carbon tetrachloride.

It can be readily seen that a regulator should be treated like the delicate precision instrument that it is. Random tinkering with a screwdriver is rarely advisable because it may do more harm than good. If points are clean and all connections are tight, major readjustments will not often be needed. When they are required, the best course is to study the manufacturer's recommended checkup procedure, to make each readjustment singly, and to verify each new setting with an accurate meter.



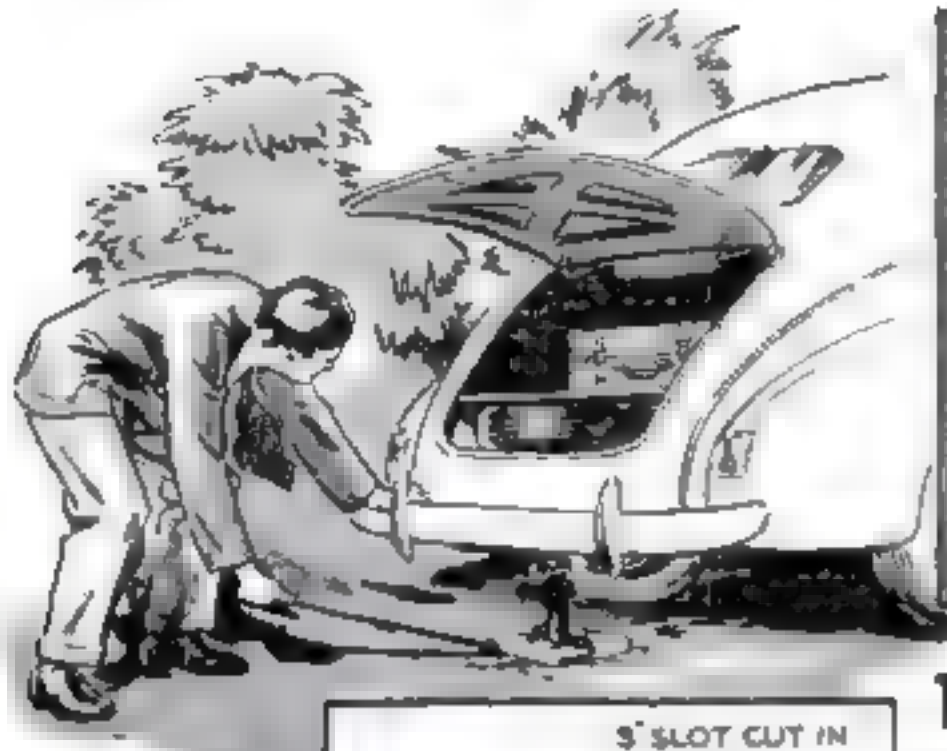
HOW A GENERATOR REGULATOR WORKS

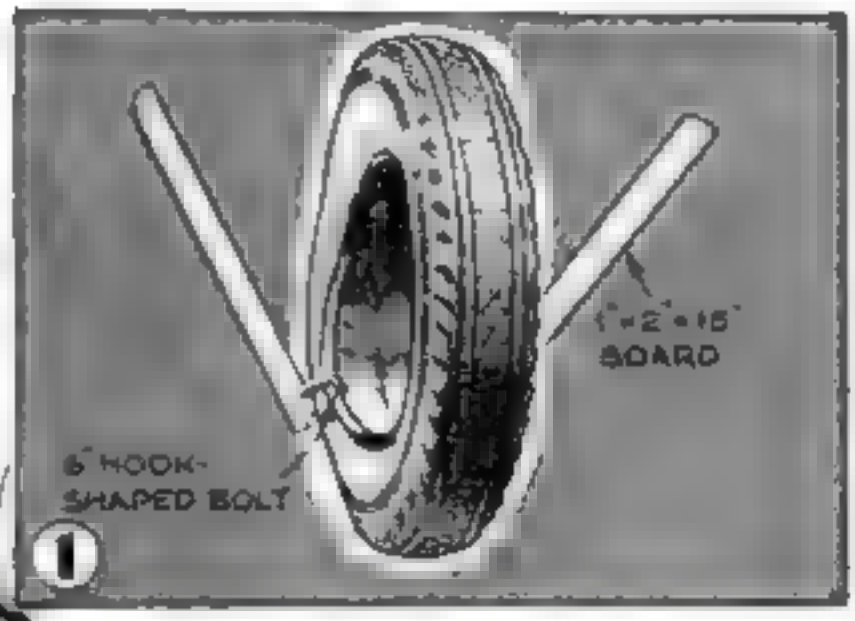
THOUGH seemingly complicated, a generator regulator is not difficult to understand. As the generator picks up speed, voltage builds up in the two windings of the cutout, creating two magnetic fields which together overcome a spring pull and close the points. The battery is then being charged. If the generator output drops off to the point where the current would flow back from the battery, the direction of flow through the heavier winding is reversed whereas the flow through the other winding is *not* reversed. The two magnetic fields then cancel each other and the spring pulls the points open.

The voltage regulator operates on the principle that as a battery nears its full charge, the voltage in the charging circuit tends to increase. This regulator also has two windings; the heavier one is part of the field circuit so long as the points are held together by a spring, while the other carries battery current. As the battery approaches a full charge, the magnetic field built up in the two windings is sufficient to open the points. The field current must then flow through a resistance to the ground; and the magnetic pull in the regulator core is greatly reduced. The points then close again, and the cycle is repeated from 50 to 200 times a second.

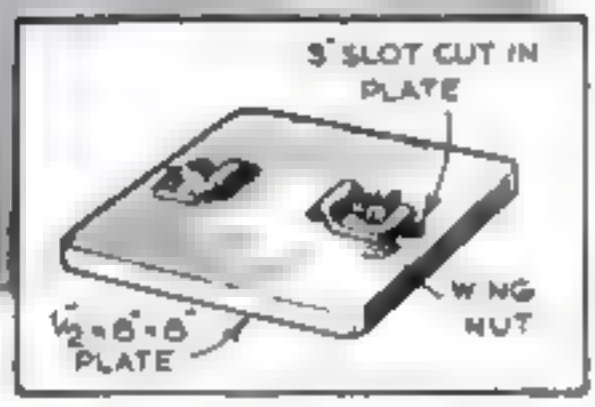
In the current regulator there is a single heavy winding which carries the entire generator output. When the generator begins to exceed its maximum rated output, the magnetic field generated by the winding is sufficient to break the circuit, forcing the field current to flow through a resistance to the ground. This weakens the magnetic field, the points close, and the process repeats.

USEFUL AUTO HINTS

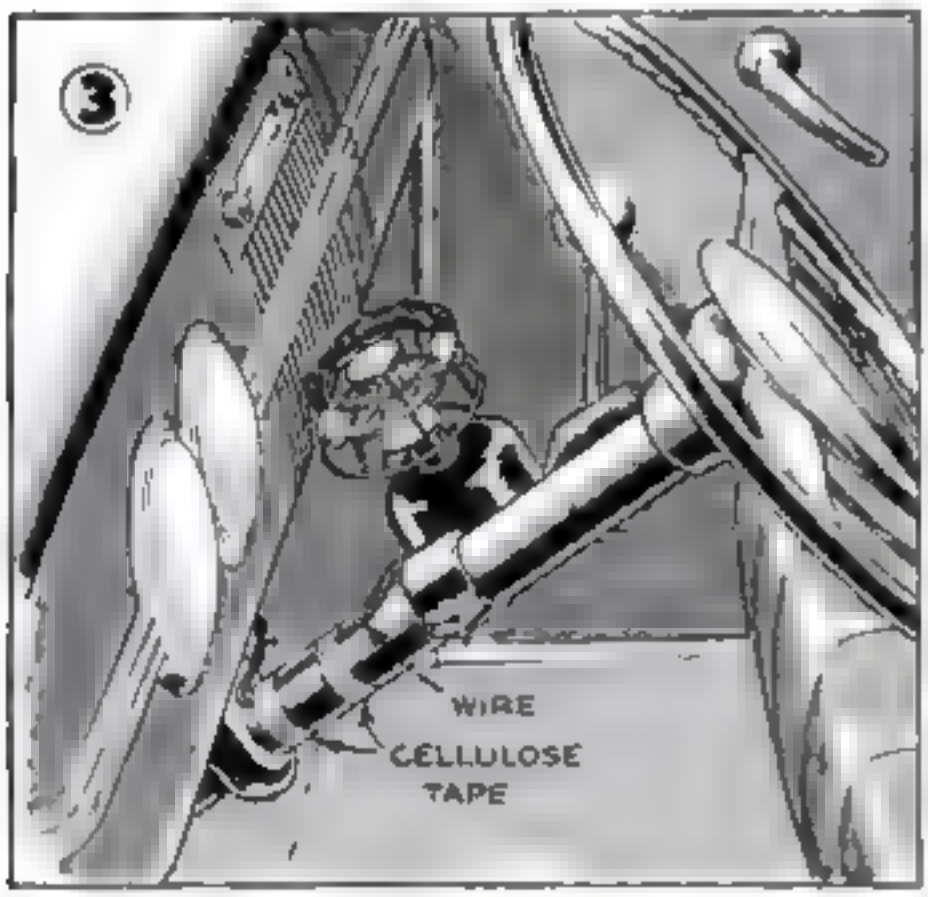




1 **TIRE INSPECTION TOOLS** can be made by inserting two 6" long screw hooks a short distance from the ends of two boards. If these are hooked over the beads of a casing and the ends of the boards are then pulled away from the tire, it is easy to look for breaks, other injuries, or nails. The tools cost little to make and may be conveniently carried in the car.—A. R.



2 **AN AUTO JACK BASE** is handy whenever a flat tire must be changed on a wet, soft, or sandy shoulder where the jack might otherwise sink into the ground. The base is also valuable even on firm ground because it adds to stability and minimizes the chance that the car may fall off the jack. Bolt the two strap-iron clamps to a ½" metal plate that is at least 8" square. If you are unable to obtain a suitable metal plate, hardwood 1¼" thick will serve, provided that it does not raise the jack too high to fit under your car.—H. W.



3 **CELLULOSE TAPE** is convenient for securing loose or dangling wires about the steering column and dashboard. The tape, which is inconspicuous because of its transparency, both removes a minor accident hazard and reduces the likelihood of short circuits or broken wires. It is also excellent for correcting rattles and squeaks of fittings under the dash.—E. M. G.

4 **GASKETS CAN BE HELD** in place by thread when an oil pan (or any other large part using a gasket) is being reassembled. It is often difficult to insert the bolts through the proper holes even when heavy grease or shellac is used as a binder for the gasket. If ordinary sewing thread is looped through alternate holes, the pan can be bolted on easily. Once the bolts are drawn up tightly, the fine thread will not interfere with a perfect seal.—J. K.

Stan pulled into the Model Garage with a spick-and-span sedan in tow of the wrecker

Gus Deals in Opposites

HE PROVES THAT THE SAME SYMPTOMS DO NOT ALWAYS POINT TO THE SAME TROUBLE

BY MARTIN BUNN

IT WAS getting along toward supper time of a warm fall evening, and a half dozen of us Model Garage regulars were sitting around Gus Wilson's shop watching him work, when his partner Joe Clark stuck his head in at the door that leads from the office and said: "Oh, Gus, I forgot to tell you—Alex Kerr called up a little while ago and said he wanted his car towed in. He didn't say what was wrong. I sent Stan for it. He ought to be back any minute now."

Alex Kerr is a mild-spoken, apprehensive-looking little man who runs the cigar store across the street from the railroad station in our town. Gus Wilson and he are about as different as any two men can be, but that doesn't keep them from being firm friends.

Big Ez Zacharias burst out laughing at mention of Alex's name.

"Betcha a dollar there ain't a derned thing the matter with his car," he offered, and took a big bite off a plug of chewing tobacco. "He's worse'n an old woman with that bus of his—every time he hears a rattle he's dead sure his motor's comin' apart. He only drives it a couple of days a month, and I betcha every time he brings it home he washes it off an' polishes it."

Ez chuckled at the thought of Alex shining up his five-year-old bus.

"Why, I met him at the Pleasanton crossroads one day, an' he flags me down an' asks me if the dirt road I'd jest come over was muddy. 'Muddier'n Jason's hog,' I tells him, 'but nothin' you can't plough through.' "

Ez laughed out loud and slapped his thigh with a resounding thwack.

"Alex shakes his head," Ez sputtered again after a pause, "and says he guesses he won't try it—he don't want to get his car muddy!"

"Well, Ez," Gus told him, "nobody ever will accuse *you* of taking too good care of your car. Maybe Alex is a little overcareful, but there's no *maybe* about your being overcareless!"

Ez grinned, pushed his postman's cap onto the back of his shaggy head, and shifted his quid over to his left cheek. "I can't afford to baby my automobiles," he said defensively. "I gotta get the mail over that rural route of mine, ain't I? Anyway, cars is

built to take it, and I aim to see that any car I drive goes any place I have to. When I'm deliverin' Uncle Sam's mail, I've got no time to be nursin' and foolin' around with a temperamental car."

A horn honked briefly outside the open shop door, and Stan—he's the Model Garage's current grease monkey—slowly maneuvered the wrecker and a respectable-looking '39 sedan into the shop. Alex Kerr got out of the sedan, looking even more worried than usual.

"Hello, gents," he told the Model Garage regulars briefly but courteously, and hardly waited for a reply to his greeting before jumping right to the point.

"Say, Gus," he said with a rush of words. "I'm in bad trouble. I guess I've stripped a lot of teeth out of my flywheel. That's bad, isn't it—a pretty big repair job?"

"Well, it is sort of a big job," Gus admitted. "You have to remove the transmission and clutch before you can take out the flywheel to change the ring gear. The old ring gear must be cut off; then the new ring must be heated to expand it so it can be pressed on the flywheel. It's what's called a shrink fit.

"But before we start worrying about that, let's make sure that we're doing our worrying about the right thing. Flywheel teeth don't get broken off so often. What makes you so sure you've stripped yours, Alex?"

Alex looked relieved.

"Well, it sounded as if I had," he said. "This afternoon I thought I'd go over to Pleasanton to see my sister."

"Ain'cha askeered of that Pleasanton mud hole and of using up your A coupons?" Ez asked, and he looked around at the rest of the boys with a sly twinkle.

"I got a right to see my sister," Alex retorted. "She's been sick in bed for the last month, and, anyhow, I haven't driven my car a mile in three weeks, and I always go easy on my A coupons."

Satisfied that he had justified himself, Alex turned back to Gus.

"Well, when I tried to start up," he said, "there was a terrible noise, and the motor stopped dead almost as soon as it started. I didn't know what was the matter, so I went into Henry Miller's hardware store and asked him. He came over to my garage with me, and I stepped on the starter again. The motor did the same thing—made that noise and stopped almost as soon as it started. Henry said: 'You've stripped some of the teeth off your flywheel—you better not monkey with it.' So I phoned Joe Clark, and he sent the wrecker—and here I am."

WE ALL had to laugh at the idea of anyone who was having car trouble asking Henry Miller's advice—Henry being strictly a Sunday driver and notoriously a left-handed mechanic. Even Gus Wilson had to grin at that one.

"About that noise," he asked Alex. "What did it sound like?"

"Oh, I dunno exactly—it sounded like broken teeth to me," Alex said. He scratched his head. "Wait a second, now—yes, I've got it. The noise was three or four clicks—loud ones."

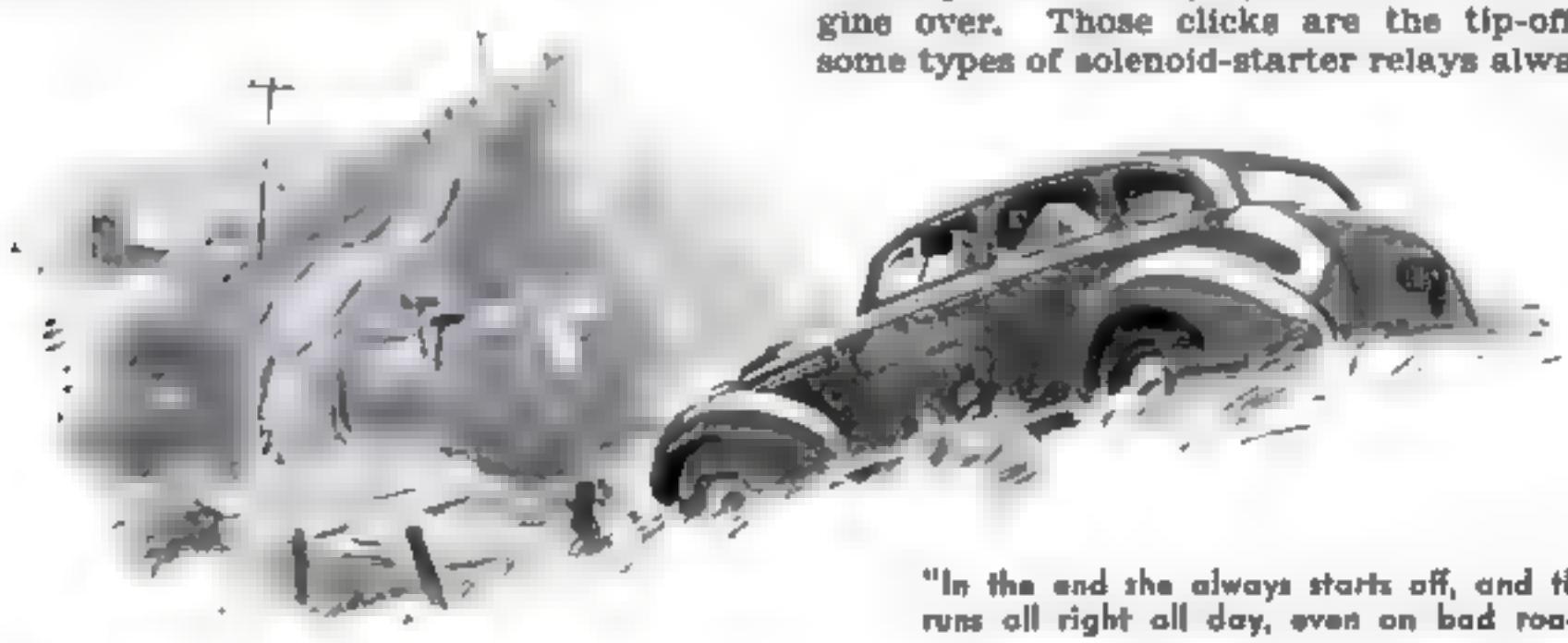
"Clicks, hey?" Gus said. He got into Alex's car and stepped on the starter. The starting motor took off, but after it had turned the engine over maybe about a quarter of a revolution there was a sharp *click-click-click-click*, and then it stopped dead.

Gus switched off the ignition and got out of the car.

"You can quit worrying, Alex," he said. "There's nothing the matter with your flywheel—none of the teeth have been broken. The only bill you'll have to pay on this job is for the wrecker and for recharging your battery."

"Recharging my battery?" Alex looked incredulous. "What's my battery got to do with it?"

"Everything," Gus told him. "Your battery is so run down that it can't feed the starting motor enough juice to turn the engine over. Those clicks are the tip-off—some types of solenoid-starter relays always



"In the end she always starts off, and then runs all right all day, even on bad roads"

give off a series of loud clicks when you step on the starter if the battery is run down. I'll put a rental battery in your bus now, and you can stop by the day after tomorrow and get yours."

AS SOON as Alex had driven out of the shop Ez Zacharias slapped his thigh with one of his ham-sized hands and let out a bellow. "What did I tell you?" he demanded. "He's just like an old maid with that bus.

"Say, I've been havin' trouble somethin' like his—only I ain't heard any of them clicks. Sometimes when I try to start up in th' mornin' my motor acts th' same way—like broken flywheel teeth was jammin' the starter-motor drive gears. The starter turns the motor over pretty near a full turn, near as I can make out, and then she goes dead.

"But I don't start worryin'. No, sir! I just wait a couple of minutes, and then step on her again. Sometimes I have to do that a half a dozen times, but in the end she always starts off, an' then runs all right all day. First off I thought my battery was run down, but it ain't. Well, cars is built to take it. What's the use of gettin' in a stew every time somethin' ain't just right?"

"You're a wonderful guy, Ez," Gus told him. "I'll bet that car of yours uses mighty little oil, too."

"Huh?" Ez grunted. "How do you know that? I don't generally get down here to town to buy my oil. But you're dead right—I never saw a car that uses so little."

"Ever take a look to see what's in your crankcase?" Gus asked.

"Me? No!" Ez said. "Why should I? Car's runnin' fine, except for that hard startin' some mornin's."

"Take a look," Gus advised. "It might save you some money."

Ez stared at him. Then he got up. "So you figger there's somethin' serious the matter, do you?" he said. "O.K., Gus—that's plenty for me. Wait a minute till I drive it in, and then *you* can take a look."

A half minute later Ez drove his mud-spattered sedan into the shop. "Have you ever washed that jalopy since you bought it?" someone asked when he got out.

"No, sir, I ain't," Ez said shamelessly. "What would be the use—I'd get it all muddied up again next time it rained, wouldn't I?" He turned to Gus. "Go ahead, perfessor—let's see what's in the crankcase."

Gus placed a large can under the car and opened the crankcase plug. A black, pasty semifluid began dripping slowly into the can. Gus rolled a drop of it between his thumb and forefinger. "Sludge," he said. "Much more water than oil. Your crankcase is full of it—that's why you *thought* you didn't need any oil. Man, you've been driving this car with practically no engine lubrication. You'll be darned lucky if you haven't scored your cylinders or your pistons."

Ez was looking serious now. "What do you mean—water?" he growled. "Where would all that water come from?"

"It came from one of the cylinders," Gus said. "The odds are about a hundred to one that it got into the cylinder from the water jacket through a loose or broken cylinder-head gasket, although there is just a chance that it got in through a crack or a sand hole in the cylinder. I'll have to do some checking to make certain, but probably the trouble is a bad gasket."

Ez looked relieved. "Well, that ain't so bad that it couldn't be worse," he said. "Get it fixed up as quick as you can, will you? . . . Say, Gus, how the dickens did you know there was water in my crankcase?"

Gus laughed. "Oh, I just used my head—that's what it's for," he explained. "You said that when you stepped on your starter in the morning—after your car hadn't been used for several hours—the starting motor would turn your engine part way over and then stop; and that after you had waited a while it would give it another part turn; and so on until finally it started.

"That made me guess that your starter motor was working against water in one of the cylinders—water in a cylinder can't be compressed by the piston, but if you continue to apply pressure to the piston it will force the water, little by little, through the ring gaps into the crankcase. The fact that your car was using very little oil was good supporting evidence—naturally, all that water in the crankcase kept the oil level up, although what you were using for lubrication wasn't oil, but watery sludge. . . . I don't think you've done much real damage this time, Ez, but if you keep on misusing your car, someday you're going to get into real trouble."

Ez bit off a fresh chew.

"Who, me?" he said. "I ain't worryin'—not while you're around to worry for me!"

GUS SAYS:

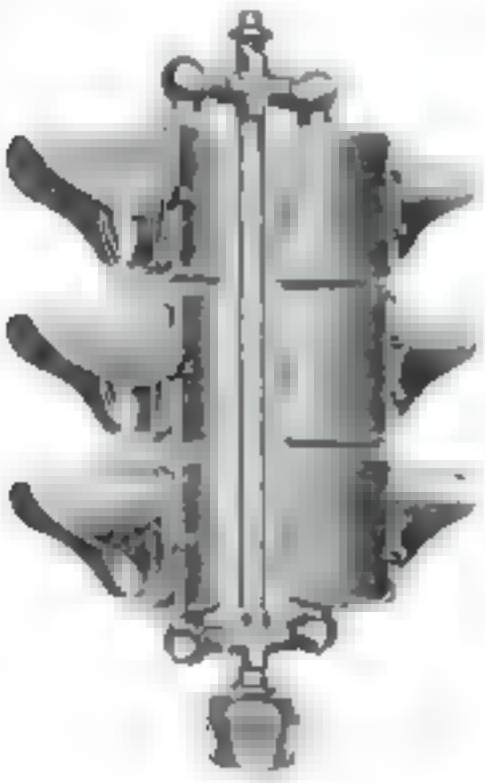
Reduced antiknock in our wartime gas gives the motorists one more thing to watch—but it isn't all bad. Some drivers have discovered that they can cut down on knocking by easing up on the accelerator. And that is a good way to lengthen tire life and increase mileage, too!

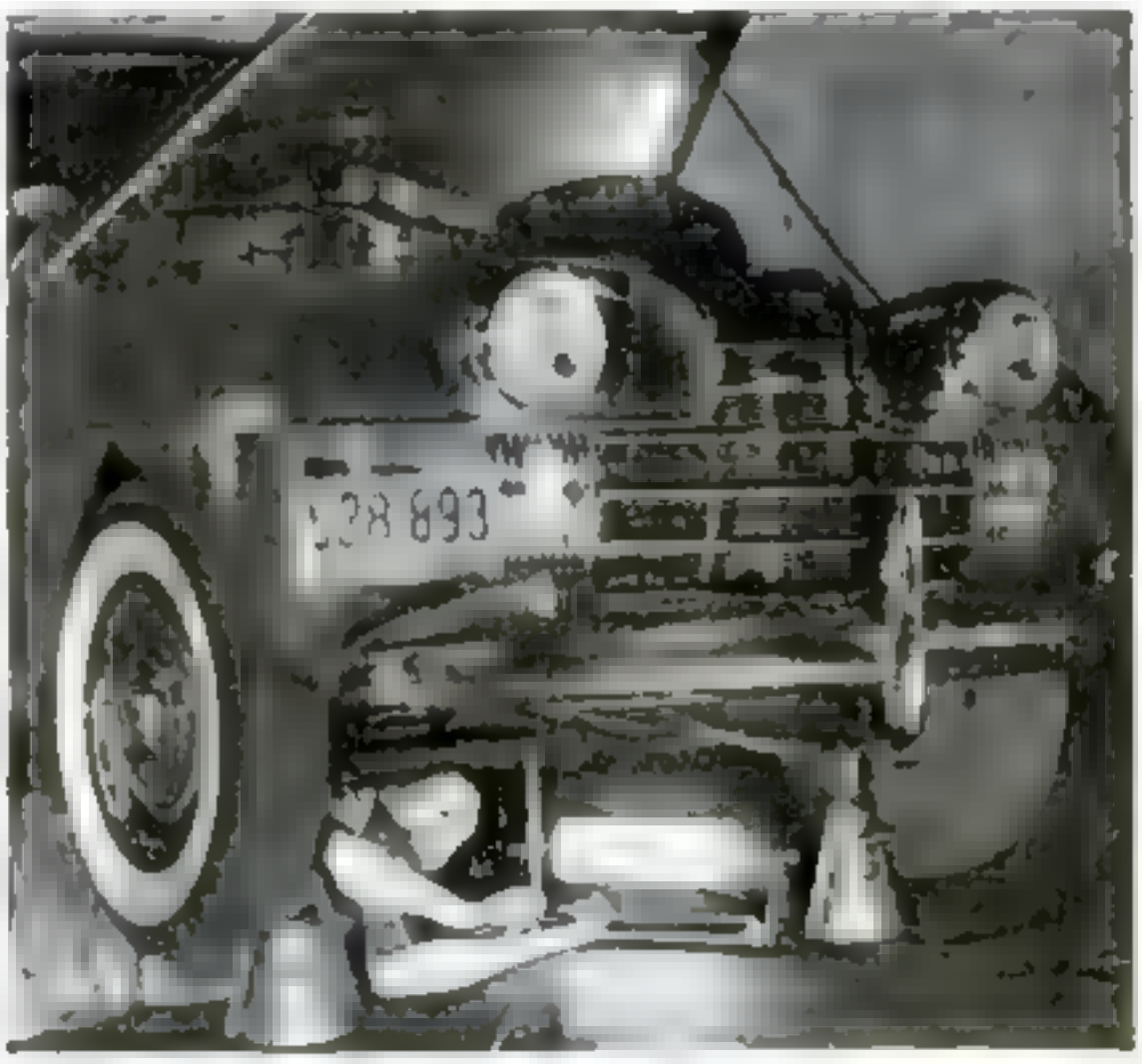
AUTO Ideas

OVERSIZE TIRES are now issued to Army motorcycle units for desert use. The tires, which are mounted on 15" rims, carry only a few pounds of air pressure for travel through sand. Armored Force officers say that they have jumped the motorcycle from the least maneuverable military vehicle in deep sand to the most maneuverable.

The photos above, taken at the Armored Force School, show the new tire undergoing hill-climbing tests and compared to a standard tire. Note the greatly increased road-bearing surface.

PHANTOM RAYS, sun reflections that may make a traffic signal seem to be lighted when the sun is low in the sky, are eliminated in a new type of light shown below. The silvered glass reflector is so shaped as to prevent the reflection of any light except that from the bulb within the signal.



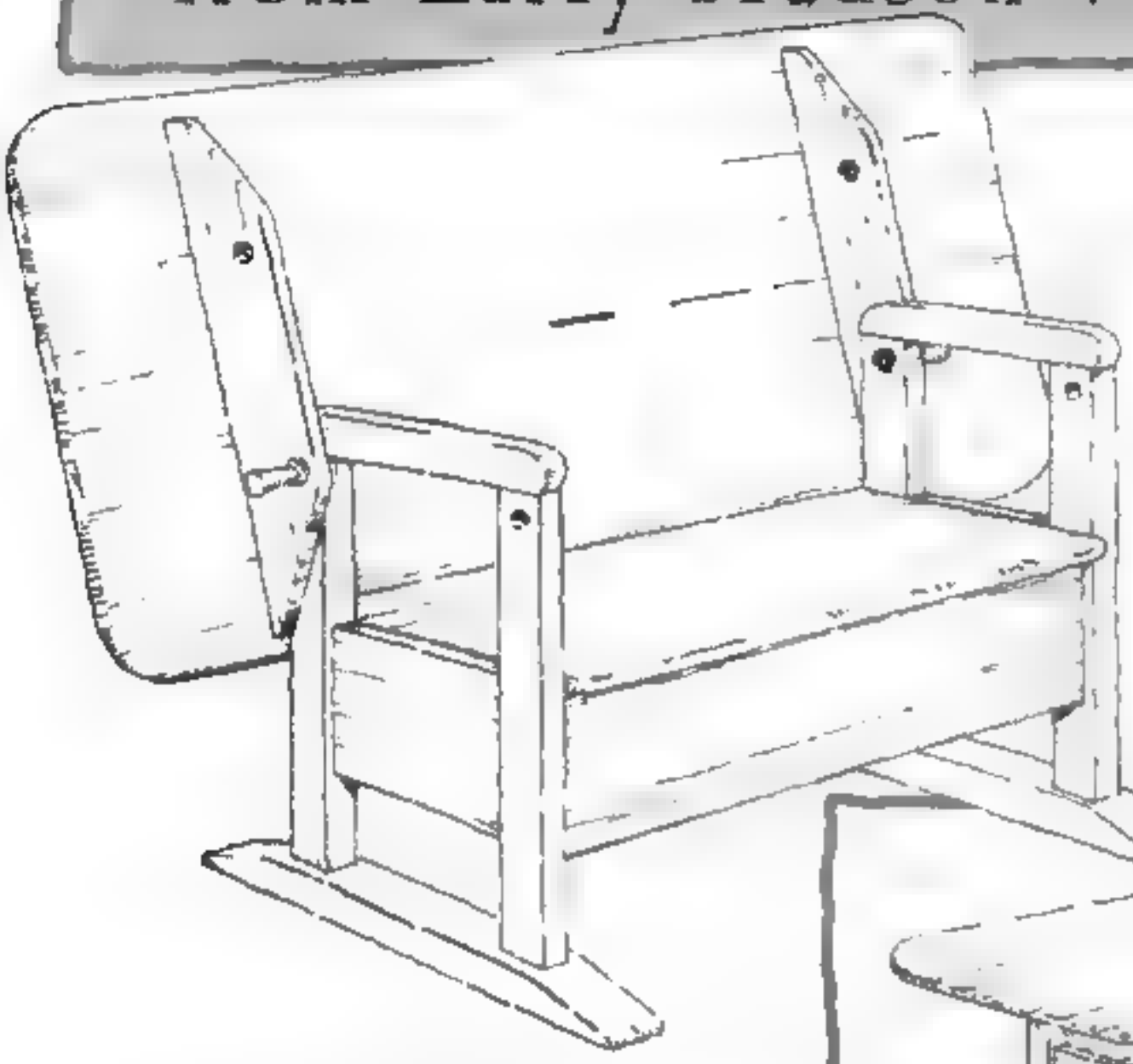


PORTABLE FLUORESCENT lighting units have been developed for use in garages. These utility lamps each contain two fluorescent tubes which are protected from breakage by a clear plastic guard. The lamps may be used on casters under autos or suspended like droplights.

HOME AND WORKSHOP

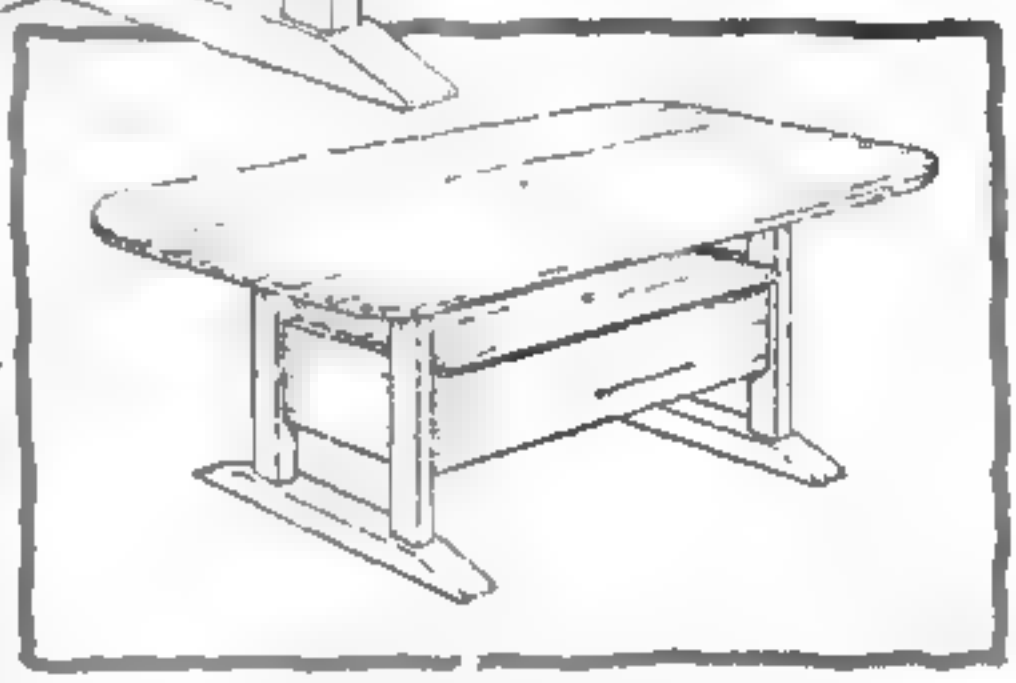
Here is another handsome and useful piece from the workshop of Joseph Aronson, who is well known to readers of POPULAR SCIENCE as a designer of authentic interiors. He developed it from furniture that has been in demand since its introduction by Tudor craftsmen. Duplicated in the home shop, it will serve as table and bench on a terrace

OLD DUTCH SETTLE
from Early Hudson Valley Days



A TABLE, BENCH, AND STORAGE BOX IN ONE WILL MAKE AN IDEAL PIECE FOR YOUR COUNTRY OR SUBURBAN HOME

By
JOSEPH ARONSON



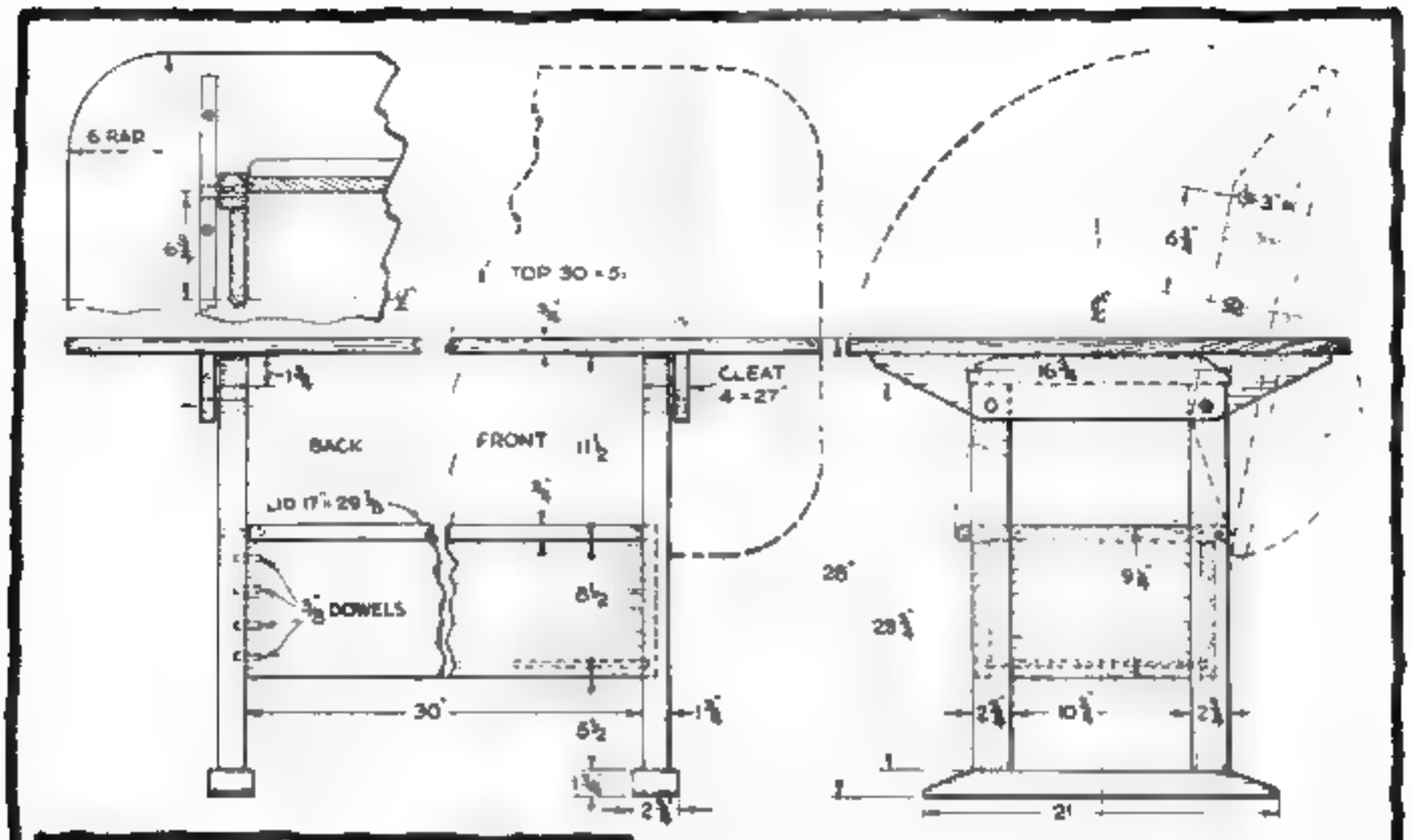
THE box settle or table settle is an old furniture form. Tudor designs of this type reappeared in American furniture of the 17th and 18th centuries, and in simplified versions the settle still appears in country homes up to the present day. The model illustrated was designed for and used on the covered terrace of a modern American home, doubling as table and bench as the occasion required.

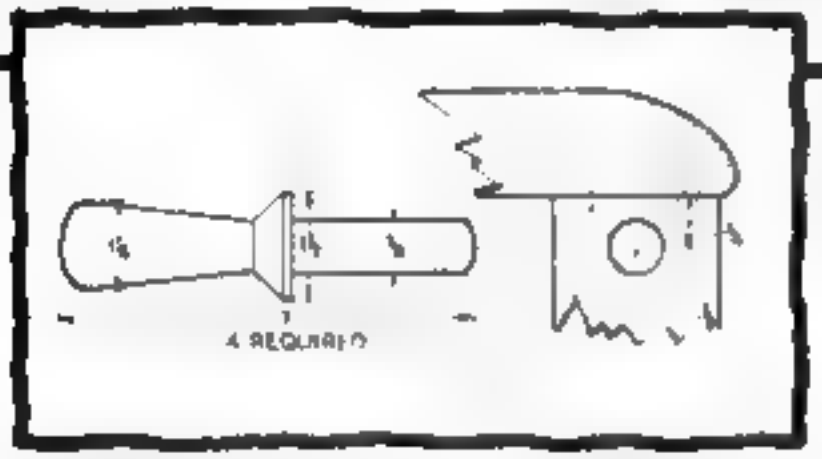
A storage compartment is an authentic part of this piece and accounts for its part-time name of box settle. One other name, Dutch settle, stems from its popularity with the Hollanders who settled in the Hudson Valley. The term "settle" itself has nothing to do with settlers, but is an old word for bench, especially a bench with a high back.

The basic construction of this table settle is elementary, and the materials may be of the average lumber-yard kind. Posts and top stretchers should be selected from the best sections of 2" by 3" pieces of fir or pine, planed and sanded smooth, and then doweled together. Note that the box ends are placed so that their top edges come flush with the top of the box lid, and ¾" higher than the box sides upon which the lid rests. Both ends and sides are fastened to the posts with four dowels at each end.

For the box floor, if ¾" plywood is not available, ⅝" material may be used. Ends and sides of the box are rabbeted to receive the floor, which has its four corners notched out to fit around the posts. The lid should be glued up and reinforced with cleats screwed to the underside. Metal hinges may be used, or dowel pins may be put into the lid from the posts, but be sure to get the dowel centers outside of the back of the box as shown in the drawing.

Material for the top should be selected from clear, straight stock and carefully glued up. Deep cleats, which are screwed on, will help keep the top straight. Pivoting of the top is by means of the turned pins inserted through holes in the cleats into cor-





Front and side views of the table settle, above, show in detail how this triple-purpose piece is constructed, while at left the drawings are of a table-top pin and a doweled stretcher-post joint

responding holes in the posts. The position of these holes must be exact or the top will either rest at a bad angle when up or not set properly on the arms when down.

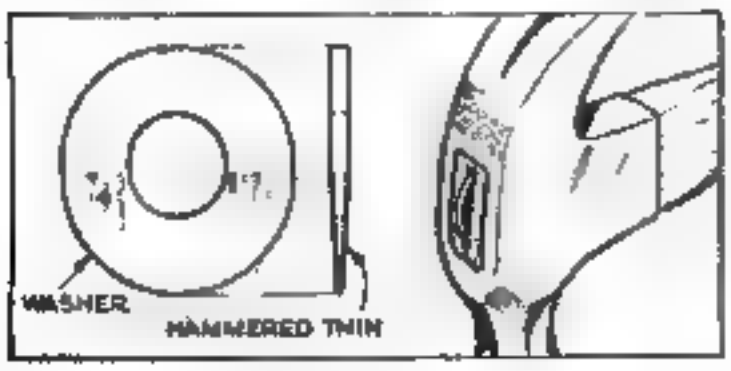
Finish the table settle to suit its intended use. If the wood you use has an interesting texture, a pleasing finish can be made to simulate old pine or maple with a water stain of light walnut color, brushed over when dry with shellac and thoroughly sanded to a satin smoothness. On the other hand, a note of strong color is pleasant for porch or terrace furnishings, and some decorators would be tempted to try strong red, blue, or yellow paint.

LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
4	Posts	1¾	2⅜	23⅜
2	Stretchers	1¾	1⅞	16¾
2	Box ends	¾	9¼	10¾
2	" sides	¾	8½	30
1	" lid	¾	17	29⅞
1	" floor (plywood)	⅜	14¼	30½
2	Feet	1¾	2⅜	21
1	Table top	¾	30	51
2	Cleats	¾	4	27
4	Pins turned 7" long from 1½" stock			

Note All dimensions are given in inches.

Improvised Wedge Made of Washer Locks Hammer Head Firmly



A LOOSE hammer head can be fastened securely and permanently to its handle by the use of a wedge made from an ordinary washer. On an anvil or a block of metal, hammer the washer to a thin edge at one side as shown in the drawing at the left. Drive it into the handle as you would a wedge. The compressed wood tends to expand back into the hole of the washer, locking it firmly.—HARRY S. ALLEN.

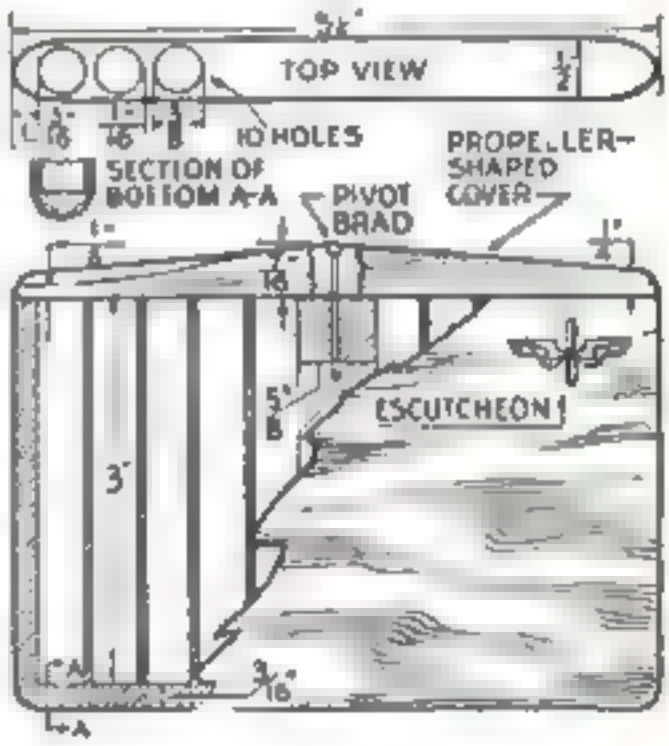
FOR THE BOYS IN THE SERVICE

CIGARETTE CASE

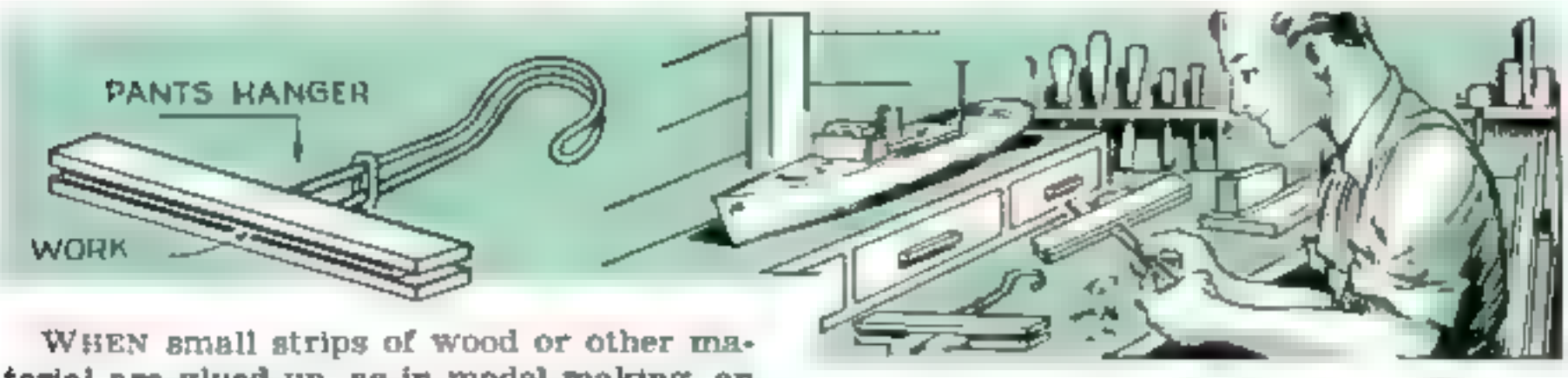
Made from a solid piece of wood, this case will hold 10 cigarettes. Its pivoted lid is held on by a brad and, as a decorative touch, is shaped like an airplane propeller

HAVE you a son or a friend in the Army Air Forces? Here is a simply made cigarette case that will be an acceptable gift. In fact, its airplane-propeller lid lends it a novelty that will make it appreciated by anyone in the services.

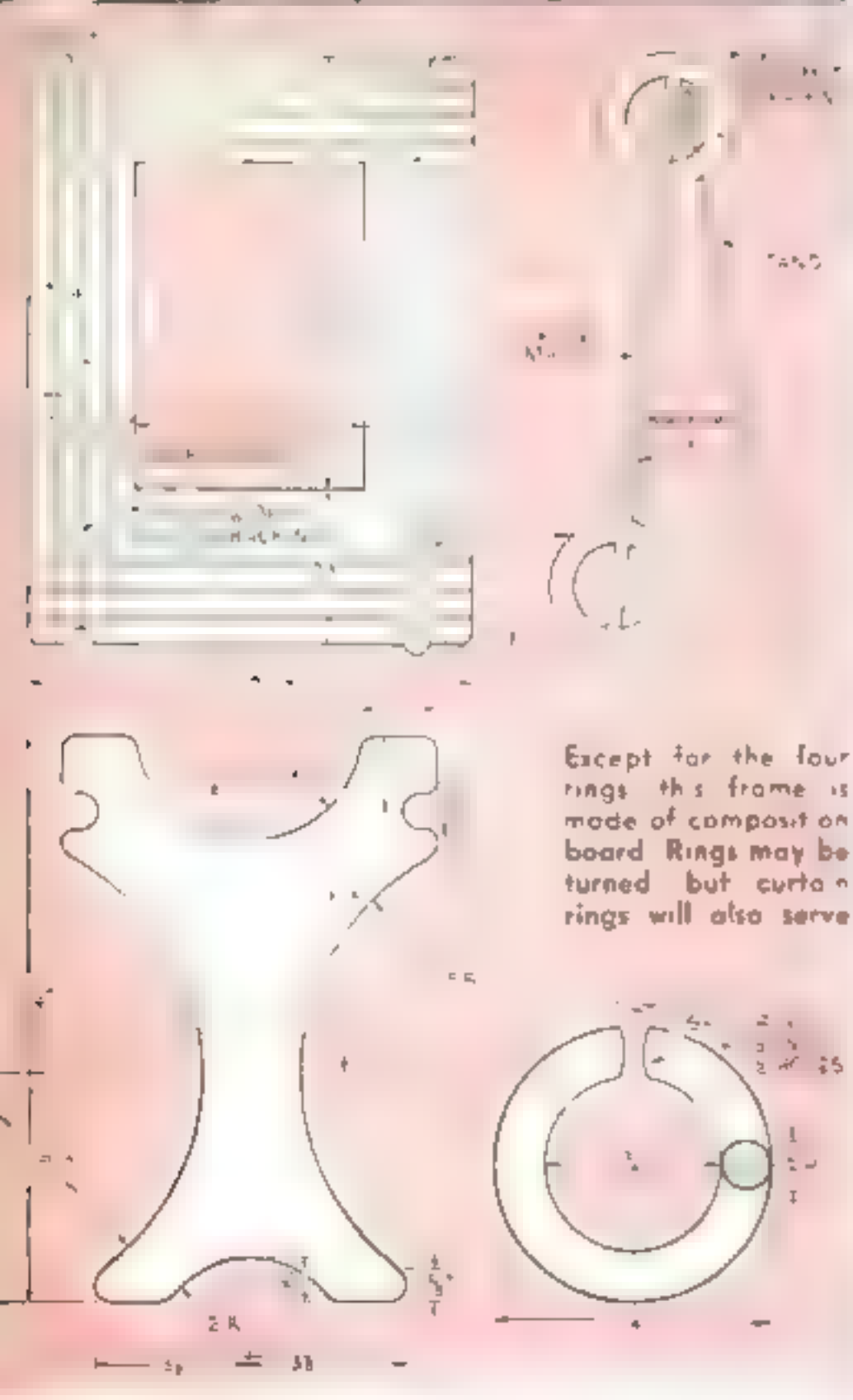
Gumwood, mahogany, walnut, or any close-grained wood is suitable for the case. Shape it roughly to the dimensions shown; then bore the ten cigarette holes—holding a half package of cigarettes—to the size in the drawing, which is just large enough to let a cigarette slip in or out. These holes are best made in the drill press, if one is available. Dress the case to shape, sand, and give it a rubbed-varnish finish. The insignia in the corner which decorates the case is taken from an inexpensive pin.—B. M.



Trousers Hanger Clamps Small Glued Parts in Model Making



WHEN small strips of wood or other material are glued up, as in model making, an ordinary trousers hanger will serve to perfection as a clamp. The device works independently of a fixed axis and will clamp equally well whether the outer surfaces of the pieces are parallel or tapered. These hangers are usually faced with felt, which will be a help in keeping tapered sides from slipping under pressure.—R. E.



HW 516

Craftwork

ATTRACTIVE PHOTOGRAPH FRAME

Designed by ERNEST R. DEWALT

EASEL PICTURE FRAME. This interesting picture frame is made of ⅛" hard, pressed composition board, as shown in the drawing. Heavy cardboard glued up could be substituted for the pressed board. The picture opening is cut in the front mat only, while the ½" holes for the rings are drilled 1/16" deep in the front of the mat and in the back of the backing. These holes are lined up to take the rings, which, when in place, hold the mat and backing together.

Make three parallel cuts on the mat on a circular saw for decoration. Cut the easel stand as dimensioned so it will open freely to the proper angle. Rub white paint into the saw cuts, and when it is dry, sand and wax the entire frame. The photo is taped in position on the backing, the mat is arranged over it, and the rings are snapped in place to hold the pieces together. Working time: 3½ hours.

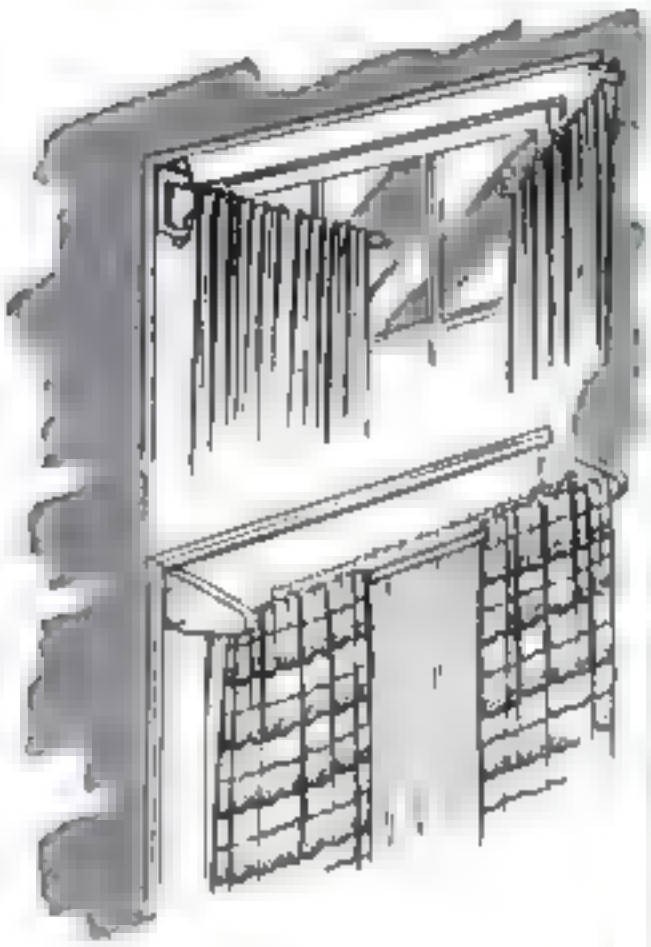
PIVOT CURTAIN BRACKETS OF WOOD. Maple pivot hinges for curtains answer a common household problem in a decorative manner. A pair of brackets and poles swing on dowel pins having beads at top and bottom. The wall mounts are fastened with long screws. Saw out the opening in the mounts, and bore and countersink two screw holes as shown. Fit each bracket in its mount so that it won't bind when swung; then, using a ¼" auger, bore a hole for the dowel pin through both parts when they are lined up.

Bore a ½" hole in the edge of each bracket for a dowel curtain pole. Round and shape the lower part of the bracket, and round the back of the bracket and the front of the wall mount to a 7/16" radius. Turn and drill beads for each dowel pin and the finials for the ends of the curtain poles. The top bead is fixed on the dowel pin with a brad; the bottom bead is removable, but it is a tight fit. Cut the curtain dowel to a length suitable for the width of curtains and size of window. Stain or paint the dowels, finials, and beads any desired color, and varnish or shellac the hinges. Working time: 3½ hours each pair.

DOUBLE WINDOW HANGER. Use maple or some other hardwood for the bracket and circular key, because the joint that holds the weight must have strength. Lay out the

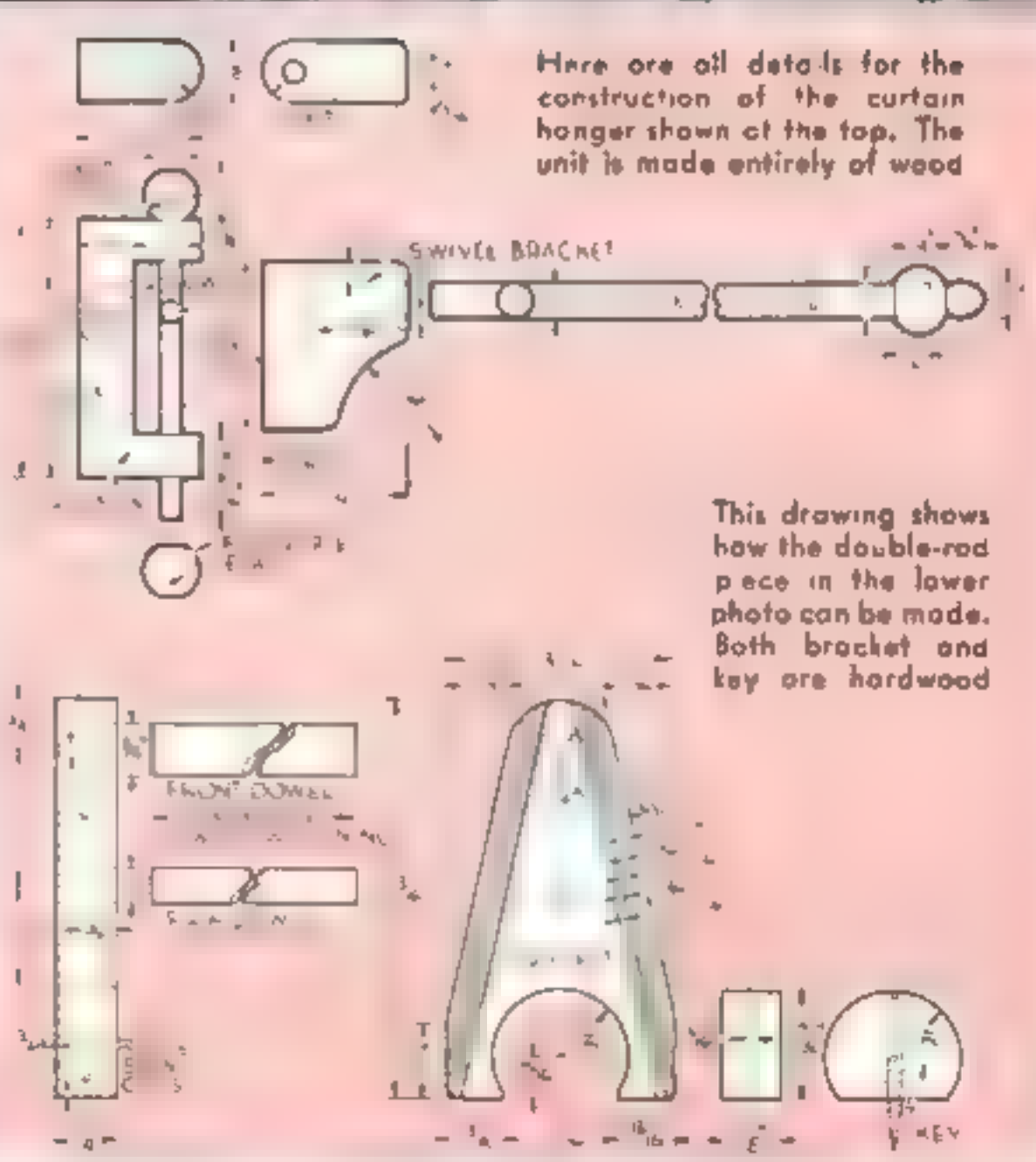
Ideas for the Home

AND TWO WOOD BRACKETS AND RODS FOR CURTAINS AND DRAPES

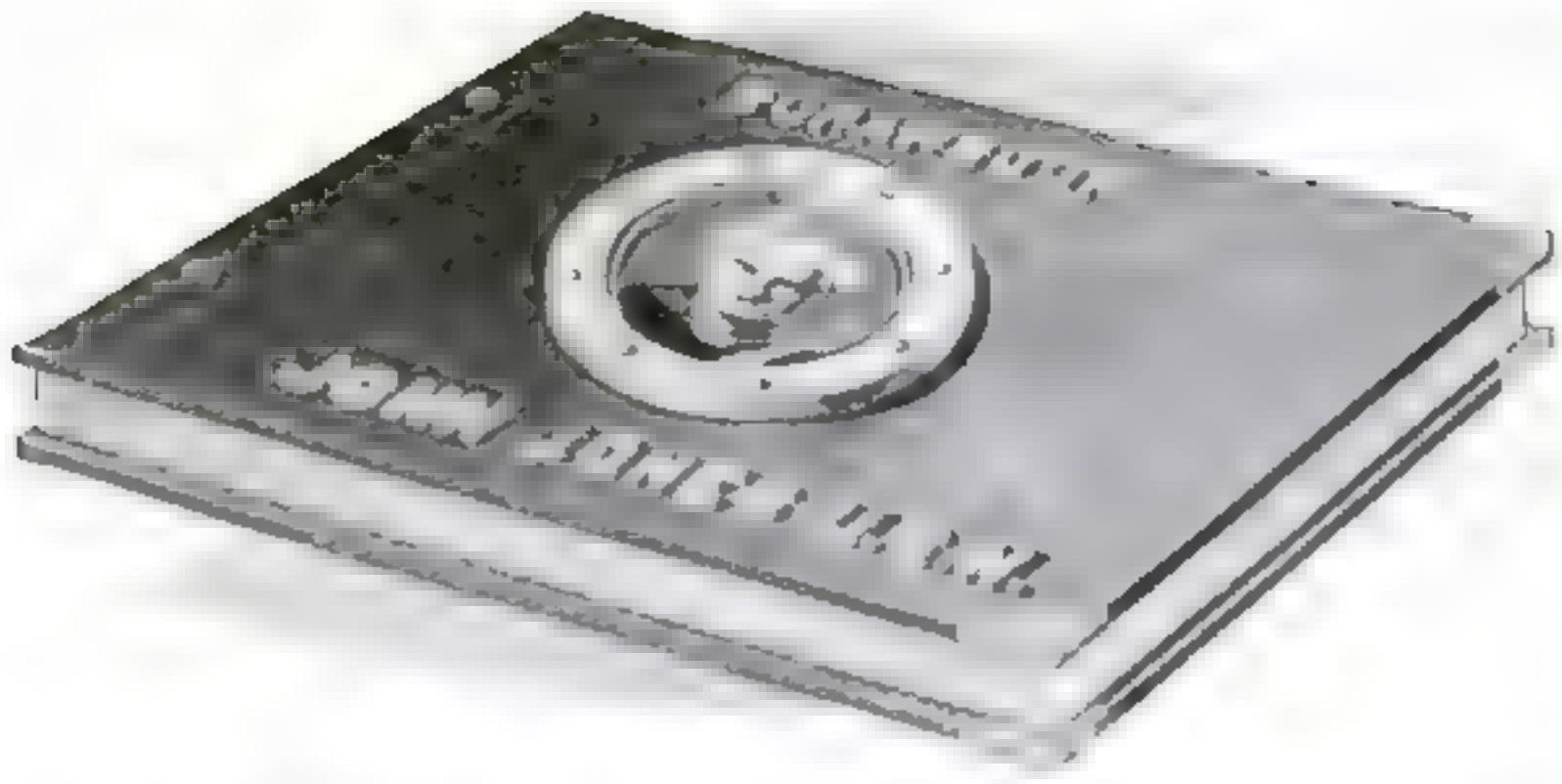


brackets from a center line and make both of them at the same time. Cut out the circles in the base and bore the holes for the two dowel poles. Round the top into the slanting sides and sand smooth. Cut the parallel grooves on a circular saw. Each key is sanded to a slip fit in the curve of its bracket. Bore and countersink each key for a 2½" wood screw. Cut both dowel poles to suit the window dimension. The finish should be such that it will harmonize with the color scheme of decorations in the room.

To install, screw the keys to the woodwork, and then slip the curtain hanger, already assembled, over the keys. The weight of window hangings will prevent slipping of the brackets on the keys. Working time: 3½ hours each pair.



HW 517



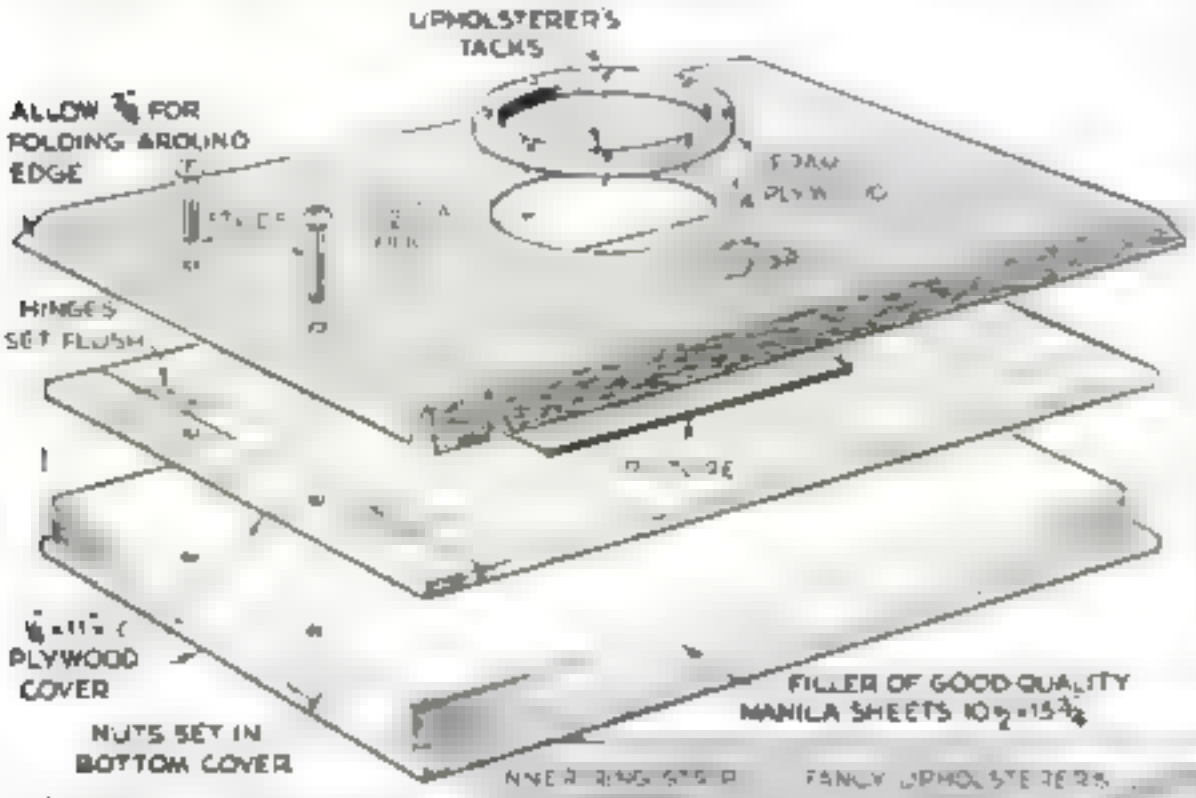
Personal Scrapbook for Mementos from Your Own Hero

ANY family with a member in the service will appreciate a personal scrapbook in which to keep clippings and pictures that are being saved for his return. The covers of this one are made of ¼" plywood, as is also the frame for the cover picture. Saw through the front board 1" from the binding edge and join the two parts with small hinges set flush. Clamp the boards together for accurate alignment and drill two holes for binding posts, countersinking the back for nuts, which are glued in place.

Coat the outside of the back with glue and stretch over it imitation leather, canvas, sailcloth, light corduroy, or other suitable material, allowing ¾" for folding over the edges. Finish the inside face with a piece of stiff paper glued on to cover the edges of the lap.

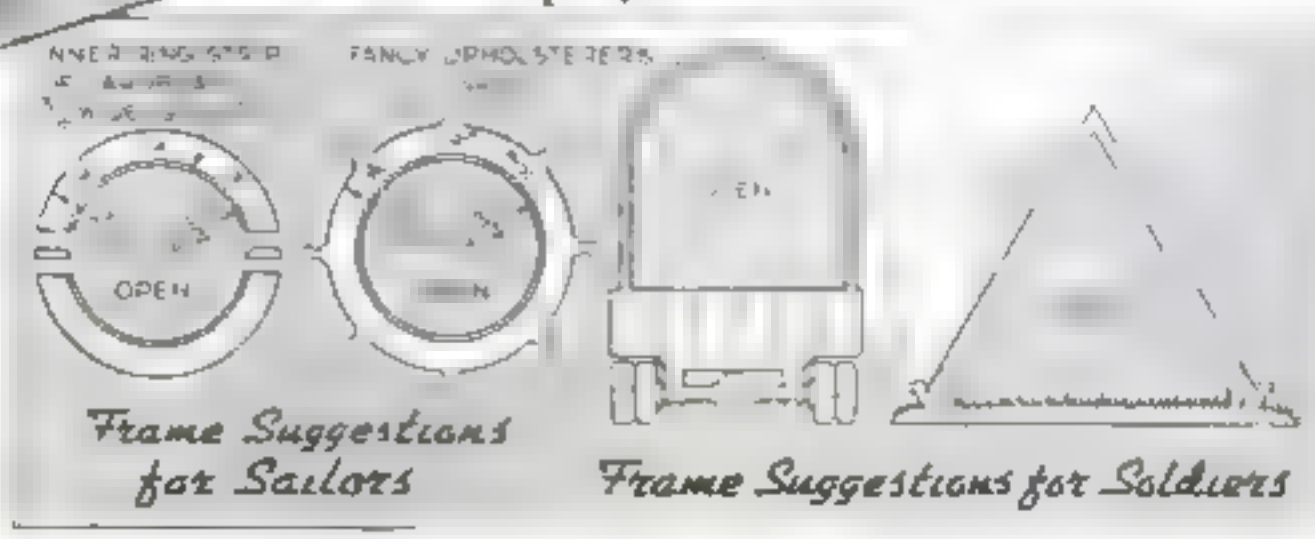
A different treatment is required for the front. Glue the covering material along one edge only, stretch it into position, and hold it with pins. Center the frame for the picture and draw a sharp knife around the inside of the opening; then remove the frame, the material cut out, and the pins. Next, center the picture in the opening, cover it with a thin sheet of transparent cellulose film, and glue the covering material down. Fold the edges and finish the inside face as was done for the back.

Alternative designs are shown for the frame, which may be glued on or fastened with upholsterers' tacks. Red, white, and blue, olive drab, or Navy blue paint may be used for a finish if the material used for the cover is such that it will take paint readily.—JOHN J. GALLIVAN.



Method of Assembly

Alternative frames for the scrapbook cover are shown at right. Use ¼" plywood except for the truck axle, which may be thinner. Any printing serves as a pattern for letters of 1/16" stock



Frame Suggestions for Sailors

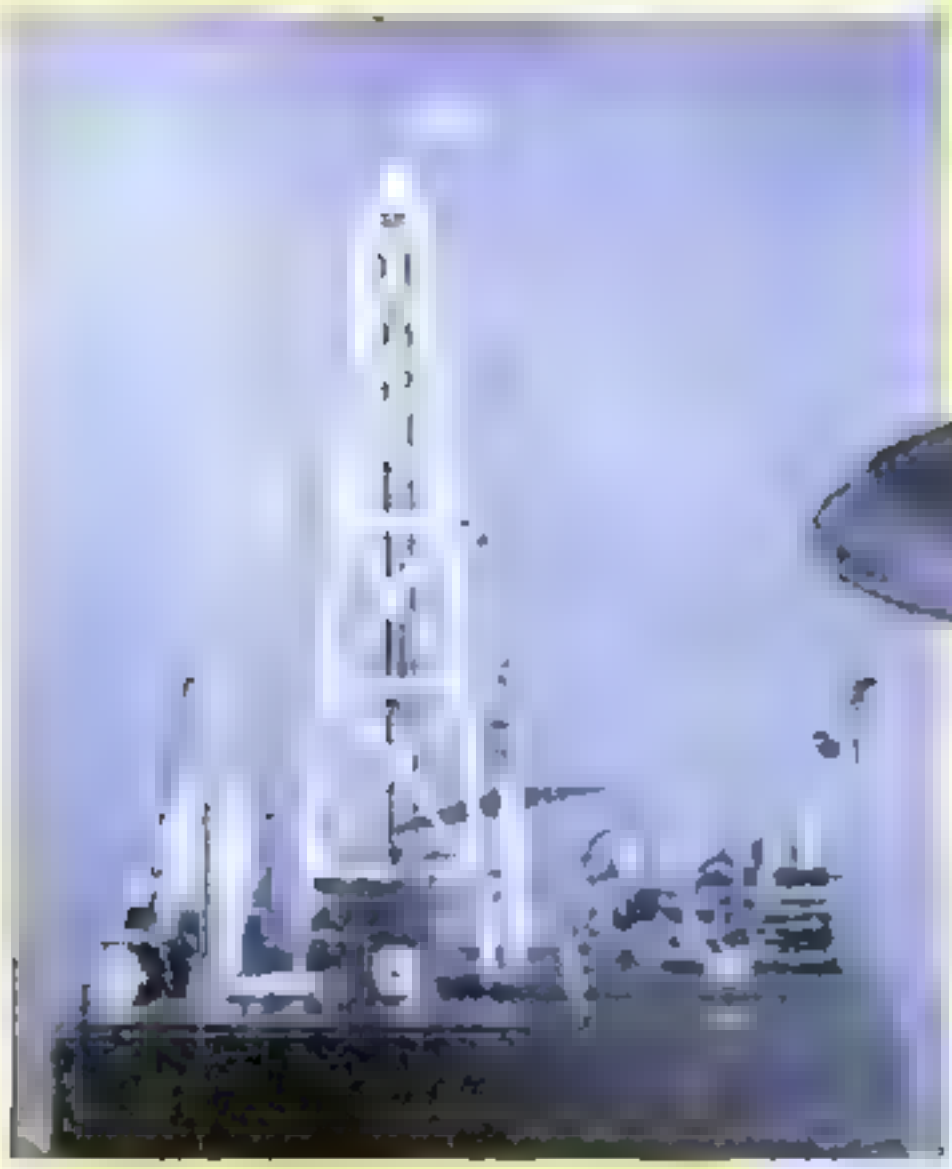
Frame Suggestions for Soldiers

from

READERS' WORKSHOPS

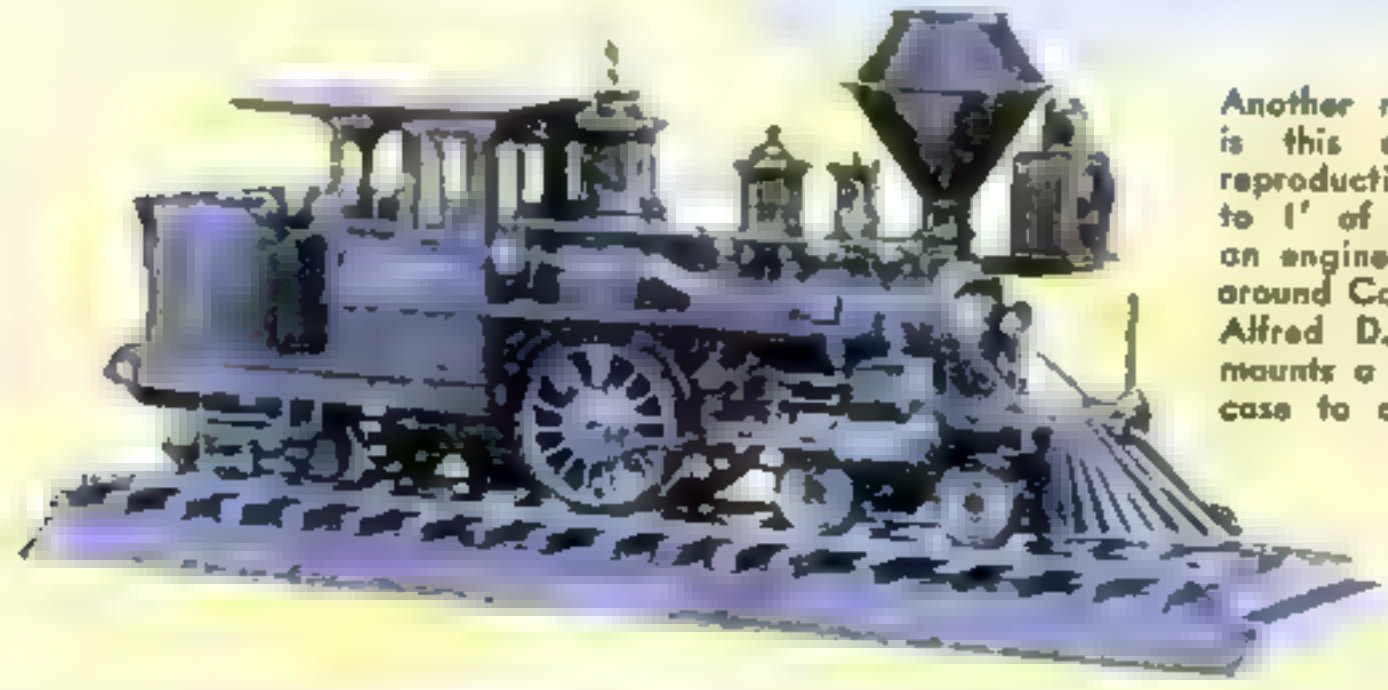
. . . ACTION MODELS DISPLAY INGENUITY OF HOME CRAFTSMEN

Capable of firing blank .32's, this deck gun has a 12" long barrel, ¾" recoil, 360-deg. traverse, 60-deg. elevation, and adjustable sights. It was built by Fred Jameson, Jr., of Omaha, and M. C. Gentry, of Detroit



Real oil is pumped by the miniature well above, which is modeled after an old-style, steam-driven rig. A 1/20-hp. motor in the base provides power for a continuous flow through ¼" pipe to a tank and return line. Jae D. Kitchen, of Coro, Mich., the designer, even included floodlights

Part of a collection of 50 models built by J. N. Holsted, of Omaha, over a period of 10 years, the two automobiles below depict a phase in the evolution of transportation. At the left is an 1898 Oldsmobile, at right, the same make dated 1903. Each is 9" long



Another model of historic value is this all-wood locomotive—a reproduction on a scale of ⅜" to 1' of the C. P. Huntington, an engine built in 1864 and sent around Cape Horn on board ship. Alfred D. Slater, of Cleveland, mounts a motor behind a display case to drive the working parts

DEHYDRATING IN ANY OVEN is now simple with a new home food drier that can be used to advantage through the growing season and into late fall. Three galvanized-wire racks hold 6½ to 10 lb. of food at one time. The unit measures 11" by 14½" by 17½", which is a convenient fit for most ovens of moderate size. Attached to it is a long, hooklike arm which can be adjusted to hold the oven door ajar for air circulation as drying goes on

THIS HANDY TOOL is made strong enough to open wooden cases and tough corrugated cartons. Besides this, the blade end of it can be used to cut cord and rope. The carton opener, as it is called, is 14" long and 1⅜" wide and has a specially shaped slot in its flat handle which can be used for pulling out nails in wooden cases. The slot is also handy for hanging the opener up when not in use. The blade is of good steel and can be sharpened on an emery wheel or a whetstone

GUMMED STICKERS that take the place of metal paper fasteners in home or office are sold in convenient sheets bound in booklet form. Each booklet contains 500 gummed stickers. The sheets are perforated to tear apart easily and quickly. Being gummed on both sides, they can be used for attaching carbon copies to letters and for mounting photographs, clippings, and souvenirs in your scrapbook or on file cards, labels on bottles, and like purposes

DRYING SMALL ARTICLES in the bathroom involves less trouble if the rack shown below is at hand. Hooked over the towel bar, it will still permit use of the latter while itself providing about four times as much additional space for hanging stockings, handkerchiefs, lingerie, and similar light laundry. Made entirely of wood, it can be put up or taken down in a moment, and holds securely in position without any other fastening

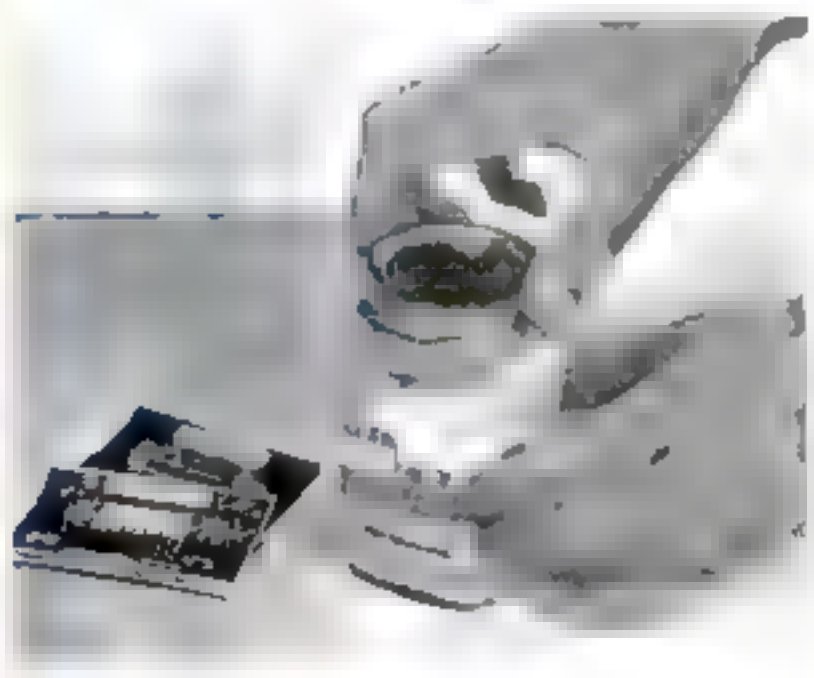
PACKAGED STRING TIES have recently appeared on the market as substitutes for rubber bands. They consist of a stiff paper square with an extra heavy disk to which a length of strong string is fastened. The ties are boxed in the form of a coiled strip having perforations which make it easy to tear off individual ties as needed. Each coil contains 250 ties. Wrapped around papers, envelopes, and small packages, the ties hold securely. They can be saved after use and put into service again and again

AIDS TO WARTIME

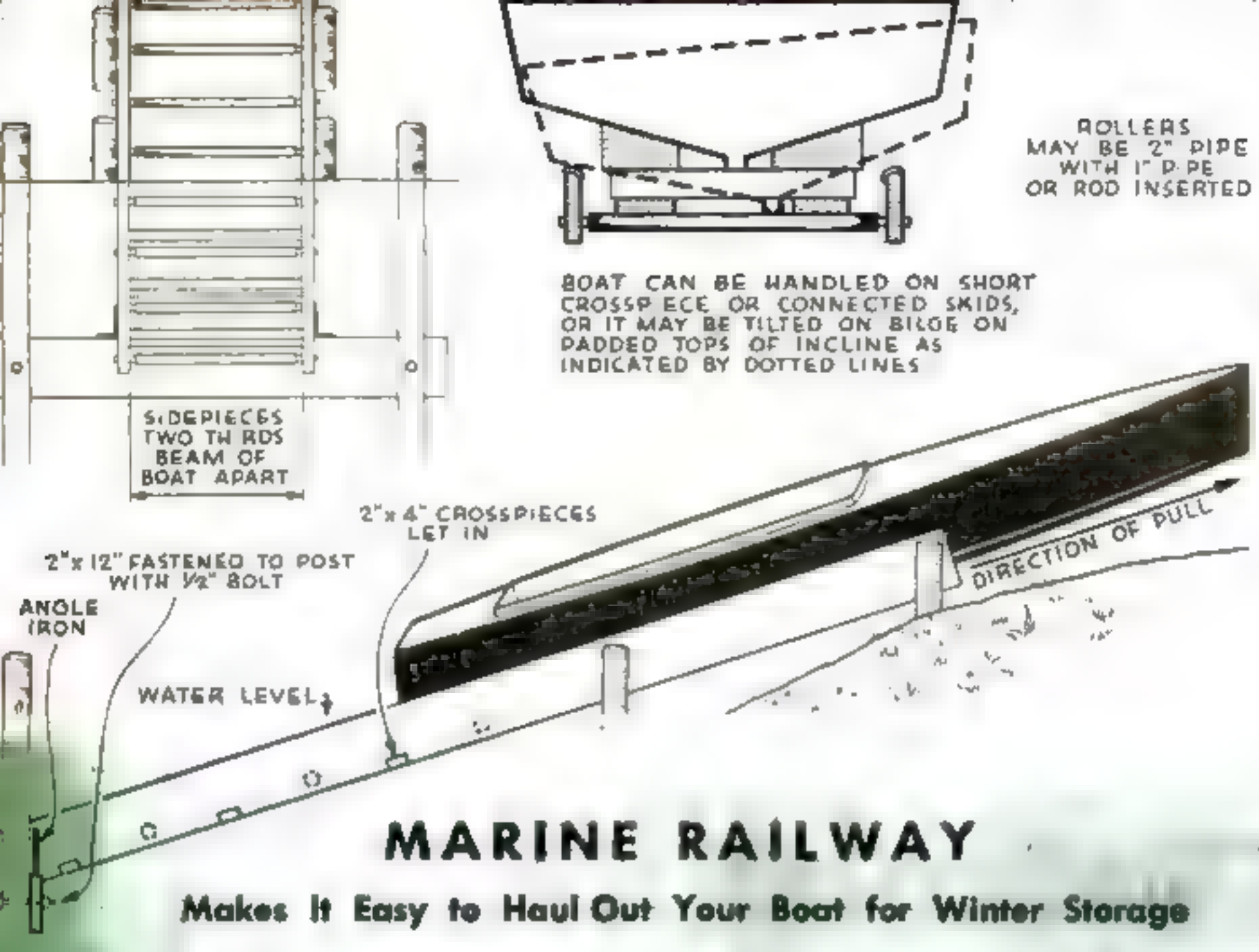
Housekeeping

CARE OF YOUR TOASTER is wise practice these days, for in most instances it will be impossible to replace it. Clean crumbs out of the inside frequently with a soft brush. If the toaster has a removable crumb tray, take it out often for cleaning. The chrome-plated outer housing can best be cleaned with a damp, soapy cloth, then rubbed briskly with a dry, soft cloth. Never put the toaster in water. Be extremely careful during all cleaning not to damage the heating elements. After using the appliance, allow it to cool off before you wind the cord loosely around it. This will lessen the risk of short circuits that might come from repeated coiling

RESLICING PRESLICED BREAD is made easy with this wooden gadget designed and hinged like the cover of a book. A slice of bread is placed between the two covers and held upright while a knife is drawn down through it to make two thin slices. The covers permit holding the bread firmly without danger of cutting the hand. Any knife with a sharp blade is used. Besides making thin slices for Melba toast, canapés, and rolled sandwiches, the unit is a help with the last end of a roast or meat loaf



PERSONALIZED LABELS are a new idea in identifying jars for families who raise and put up their foods. The labels are attractively colored and are printed with the name of the purchaser. They come gummed on one side and, measuring 2⅜" by 4", will fit any jelly or canning container. There is a space in which to write the name of the contents and the date. These gay labels will add a bright touch to the fruits of your labor, and they will also be welcome presents for a friend who puts up food



MARINE RAILWAY

Makes It Easy to Haul Out Your Boat for Winter Storage

THE incline of this easily-built marine railway is made of two planks set on edge. They must reach out to water deep enough to float the boat, and the rise should not be over 4" to 1' of length. Space the planks roughly two thirds the beam of the boat apart, fastening them with crosspieces let into their lower edges and secured with lag screws.

Rollers can be made of pieces of 2" pipe turning on longer 1" pipes or heavy rods which are fixed in the planks about 3' apart. The shape of the bottom of the boat should be taken into consideration in locating the rollers, especially in fixing the distance from them to the top edges of the side planks. Medium-sized boats can lie over slightly until one bilge bears on the top of the adjacent side plank. There will be little pressure when the hull is still water-borne, but above the water the edges of the side planks should be rounded and padded with old hose or canvas, and well greased so as to minimize friction.

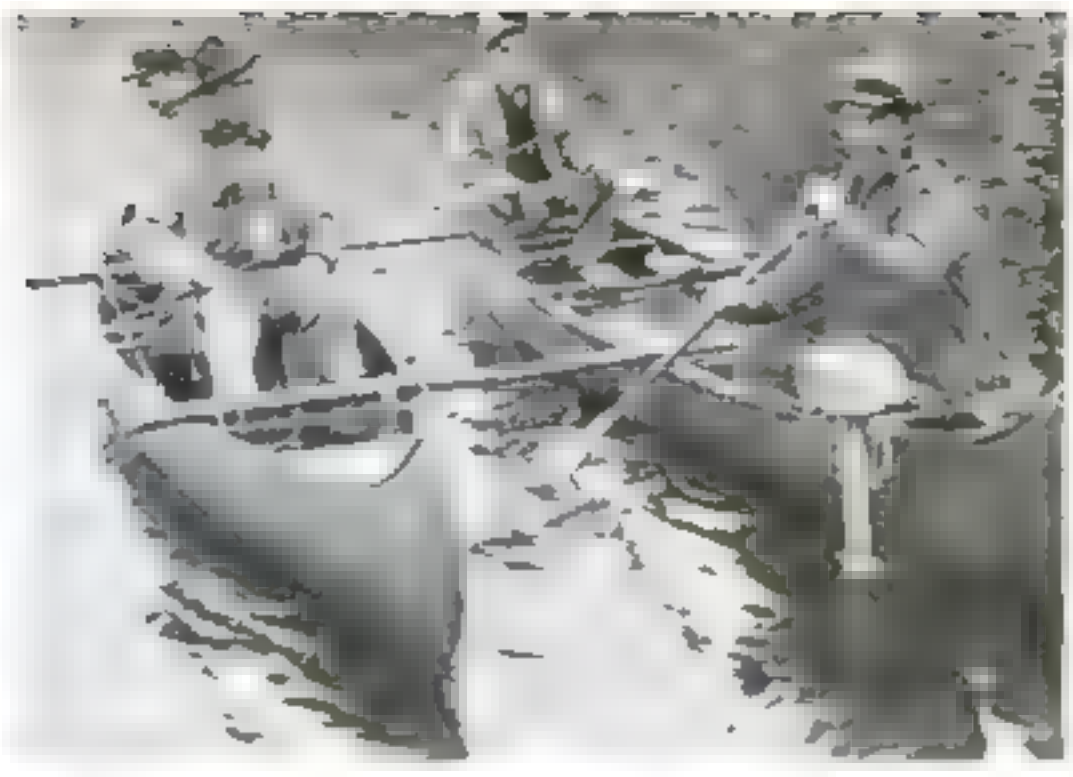
Cut notches 2½" wide by 3" deep in the under edges of both side planks about 1' from the ends to be submerged. Fit a plank across two posts, as shown in the drawings, with one bolt only in each end. The posts should be 2' wider apart than the beam of the boat. Drive the posts far enough off shore so that the cross plank can be 2' below the draft of the boat. The single bolt in each end of the cross plank will prevent excessive strain from developing while the posts are being alternately driven into position.

Float the assembled incline out over its location between the posts. Place rocks on it to submerge it so that the notches slip over the crosspiece, then fasten it there. The easiest way to do this is with strap-iron angles previously bolted on the two side planks just above the notches, each with a hole in its horizontal leg. Spikes can then be driven through these holes into the crosswise plank and bent over to hold the incline down. If necessary, you can submerge in a bathing suit and strike a few blows at a time. This fastening is merely to offset flotation, and can easily be released for hauling the railway ashore after the boat is taken out at the end of the season.

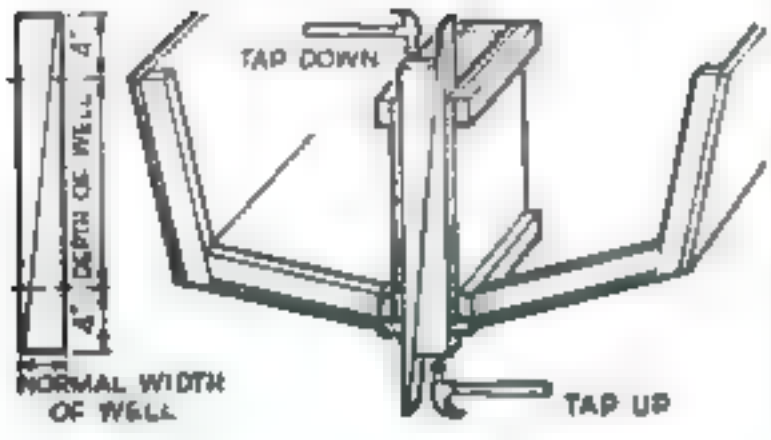
The inshore end of the railway is held securely in place by short posts. Sections can be added to extend it as far as desired. The same incline can even be carried high enough so that a truck can be backed up to the end of it and the boat slid aboard and hauled away for winter storage elsewhere.

No great power is required for hauling because of the rollers, although a block and tackle may prove helpful. Fasten the hauling gear to a heavy line looped completely around the hull and held with lighter lines across the top of the boat. This distributes the strain evenly throughout the hull instead of applying the entire load to a single mooring bitt and cleat.

BOAT HINTS



ONE OUTBOARD MOTOR used as shown above saves gas, carries twice as many passengers, and minimizes the danger of a spill in rough weather. The two canoes are held rigid with saplings lashed to the thwarts.

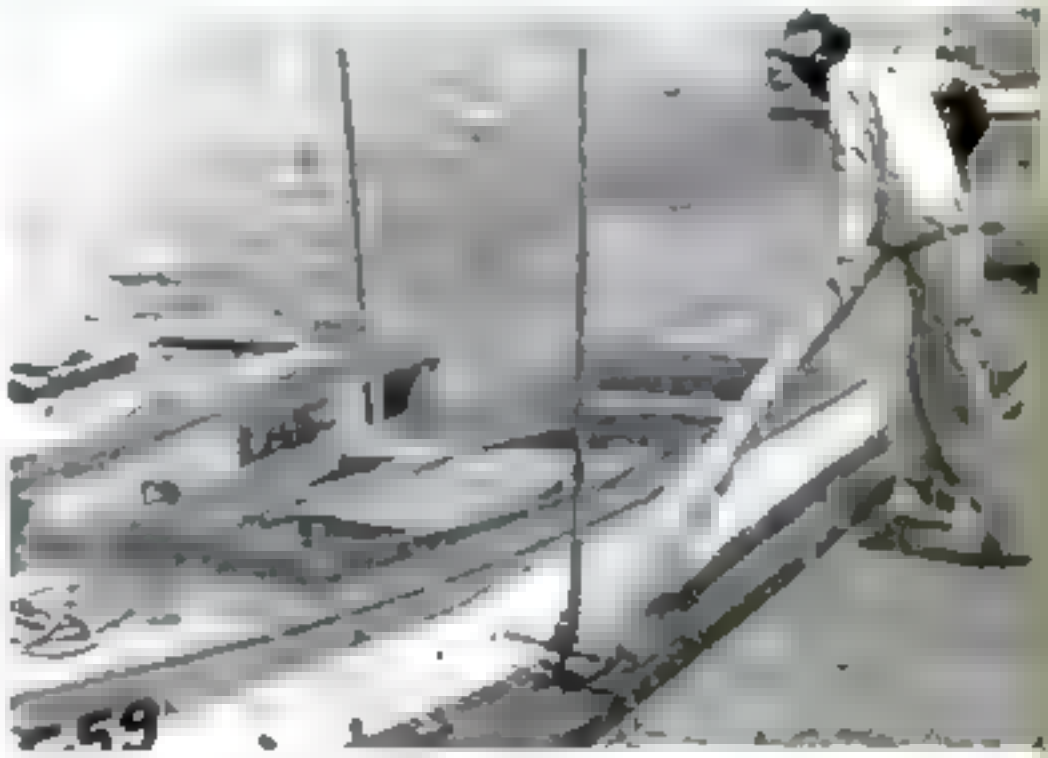


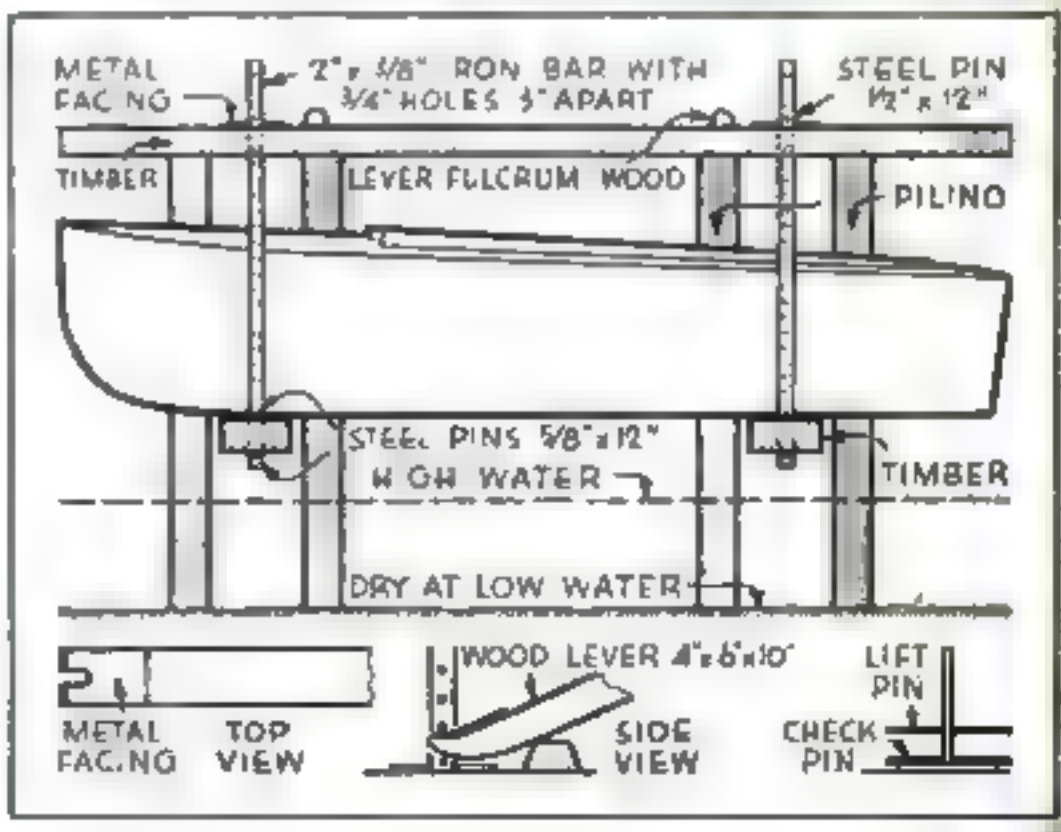
A WARPED TRUNK makes it hard to raise or lower the centerboard. To correct this condition, insert wedges at the center of the well as at the left before the boat is laid up for the winter, and leave them in until spring. Have a helper tap in one wedge while you drive in the other, being careful to expand the slot only slightly beyond its normal width.—H. S.

SMALL-BOAT DRY DOCK. Costing no more than a few dollars, this arrangement makes it easy to lift boats clear of the water for repairs or painting. Small boat yards and clubs, as well as individual boat owners, will find that it pays for itself quickly. The dimensions of the various parts will vary according to the size of the slip and the length of the boats to be accommodated. Those up to 30' in length can be raised in the dock shown at the right.

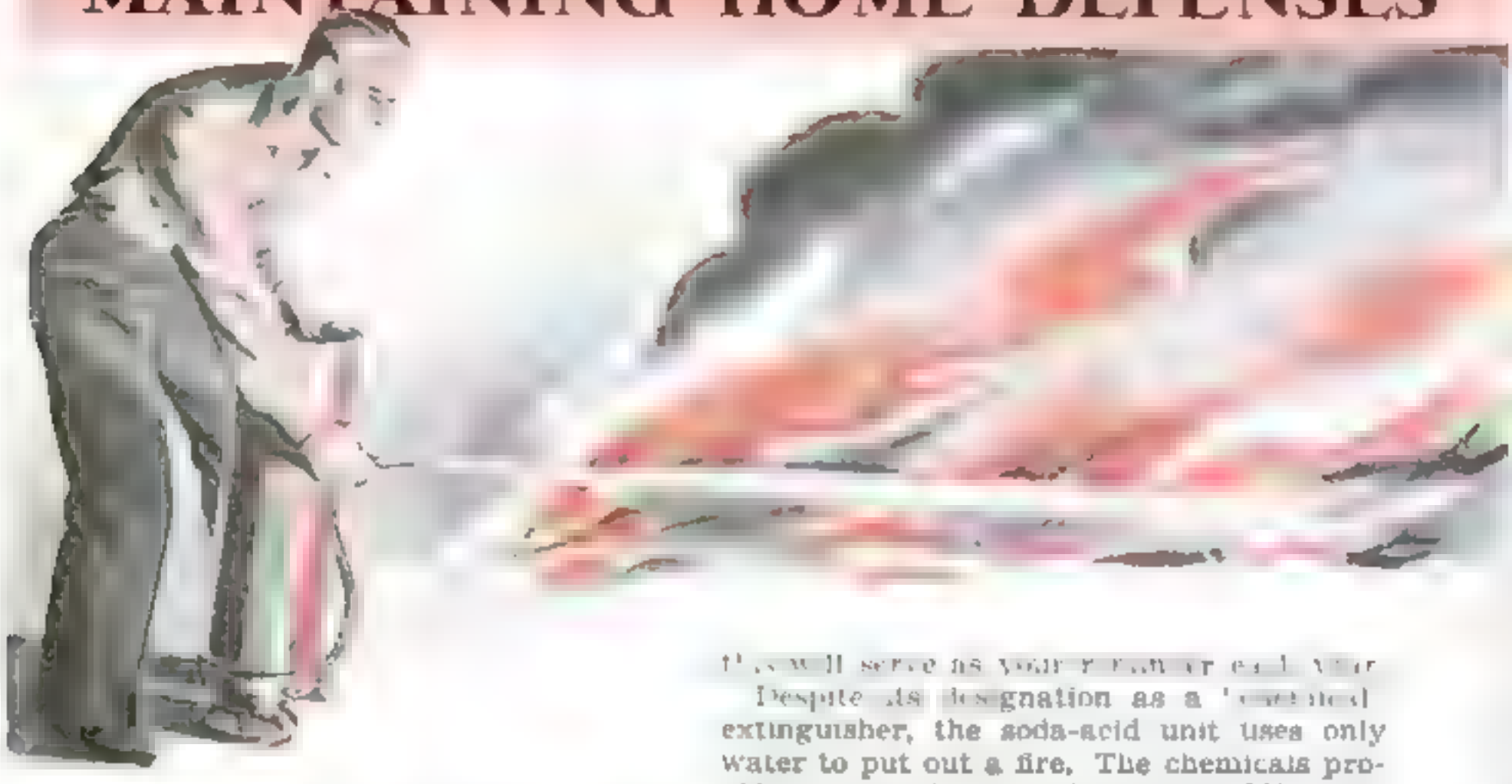
One man can readily lift a boat by means of the 10' long lever. This is hooked down to the dock at the end of its stroke so that the operator can then remove the pin which has been bearing the load in order to insert it in the new position. All four lifts should be raised to the same height before the first one is raised any further. The fork end of the lever is protected by covering it with sheet metal at the points where wear would otherwise occur.

If such a dock can be located high enough on tidewater, it is possible to make repairs to the bottom of a boat while standing on dry land. Away from tidewater, the top of the slip should be high enough above water level to give sufficient space for one to work conveniently on the bottom of a boat from a dinghy or wherry.—BRUCE MACINTOSH.





MAINTAINING HOME DEFENSES



A FIRE extinguisher is a front-line weapon against fire. But, as with other weapons, its effectiveness depends on its ability to do the job for which it was designed, on its upkeep, and on the skill with which it is used.

Only three types are ordinarily found in residences. One, the soda-acid extinguisher, will combat fires fed by ordinary combustibles, such as wood, paper, and textiles, but not those involving inflammable liquids or electrical equipment. Another, the foam type, can smother a gasoline or oil fire, but must not be used on electrical apparatus.

The third—the familiar pump-gun vaporizing-liquid extinguisher—employs a carbon tetrachloride base instead of water and may be used on any kind of fire, but it is rarely made in very large sizes. On coming into contact with heat, the stream from this extinguisher breaks down into a vapor that displaces oxygen and thus smothers the fire. This vapor is a nonconductor, will not damage mechanical or electrical installations, and leaves no residue.

All of these units should be inspected at least once a year. The hose, gasket, nozzle, outer shell, and seams should be examined for signs of clogging, corrosion, denting, or tampering. If repairs are needed, they should be made by the manufacturer.

The soda-acid and foam extinguishers also require annual recharging, which can be done at home, preferably outdoors. Directions on the labels should be carefully followed, utensils should be dry and clean, and only refills recommended by the maker should be used. If you mark the date of maintenance on a tag attached to the handle,

[illegible] will serve as your reminder each year.

Despite its designation as a "[illegible]" extinguisher, the soda-acid unit uses only water to put out a fire. The chemicals provide pressure to throw the stream 30' to 40'. This pressure is supplied by carbon dioxide gas formed by the reaction of sulphuric acid with bicarbonate of soda when the extinguisher is inverted for use.

After the unit has been emptied to take its annual recharge, unscrew the ring-top handle and remove the acid bottle; then wash all interior parts thoroughly with clean water, draining the water through the hose. Dissolve the powdered chemical refill in warm, not hot, water, as directed on the label; pour the solution into the extinguisher to the point marked; and finally replace the acid bottle in its cage. When the cap is screwed back on the shell, make sure that at least four threads are engaged. A small amount of petroleum jelly rubbed on the threads will make this easier and facilitate removal for the next recharge.

The foam extinguisher looks like the soda-acid unit, and its parts are handled the same way when it is recharged. If you have any doubts about the kind you own, the Underwriters' rating on the label will identify it. The soda-acid type is rated *A* (for use on ordinary combustibles), while the foam is rated both *A* and *B* (the *B* meaning for use on inflammable liquids). Two chemical solutions must be replaced in the foam-type unit—one in the inner chamber and one in the outer. Directions on the label should be followed, and only the materials recommended should be used.

Vaporizing-liquid extinguishers are the easiest of all to service since they need recharging only after use, but the pump action should be tested annually by discharging a portion of the liquid into a clean dry con-

AGAINST FIRE

Extinguishers Must Be Ready for Instant Action . . . Here Is How and When to Service Them

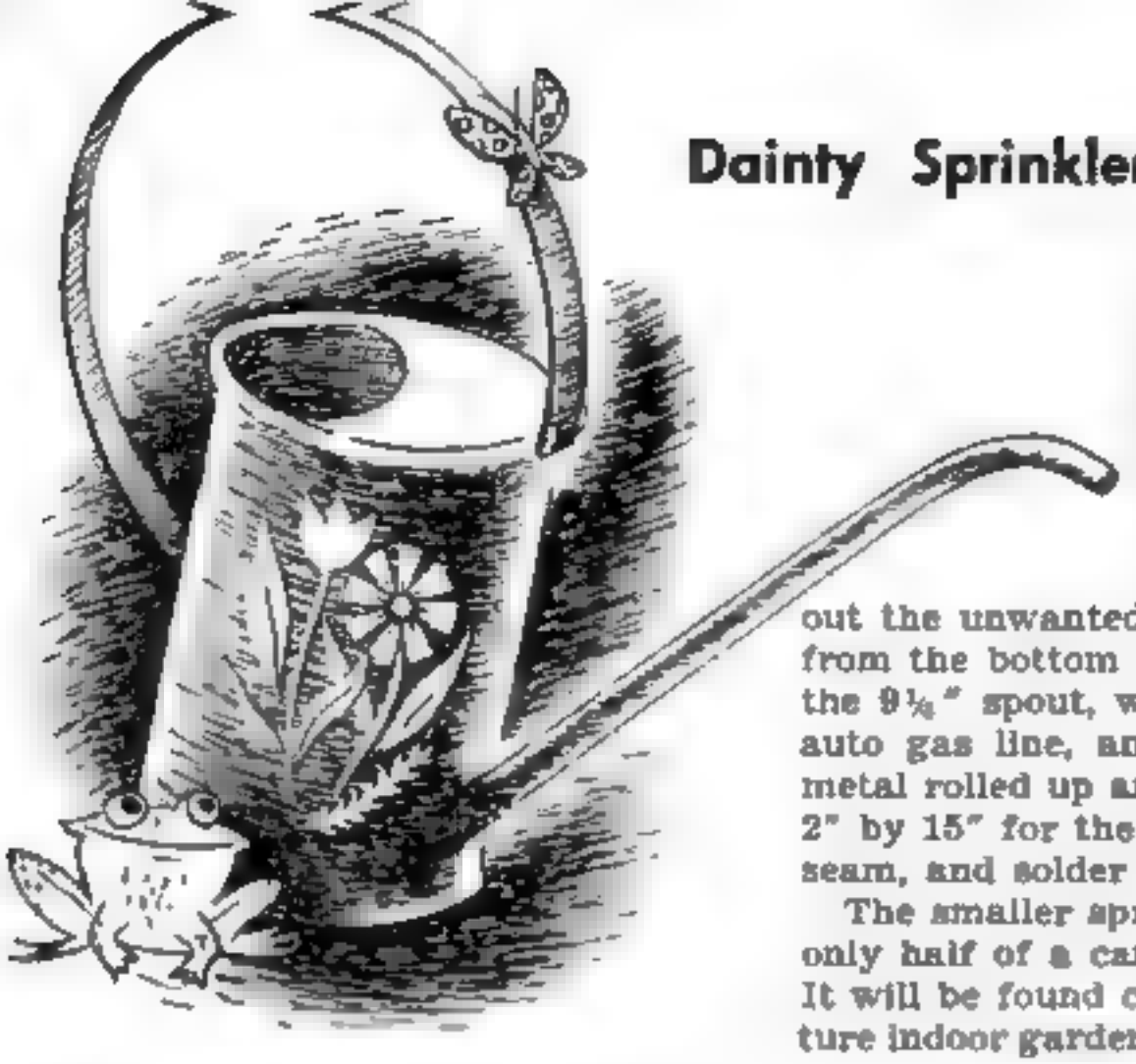
By

DELBERT JOHNSON
Safety Research Institute

tainer. This test liquid can then be poured back through the filler opening. No lubricant should be used on the piston. Because ordinary commercial carbon tetrachloride may corrode and damage the extinguisher, use only the maker's processed refill.

Soda-acid and foam extinguishers located on a porch, in a garage, or in any exposed place should be housed in a tight cabinet that can be heated by a 50-watt bulb to keep the water from freezing—don't try to use an antifreeze chemical. A simple cabinet of ⅞" stock will suffice unless you live in a section where temperatures go below zero, in which case double-wall construction is needed. For this, make the outer walls of ½" stock, and arrange a lining of ⅛" wallboard or similar material, leaving a ½" air space between the the two walls. The door should also be of double construction, closing into a rabbet and held shut with a spring latch.

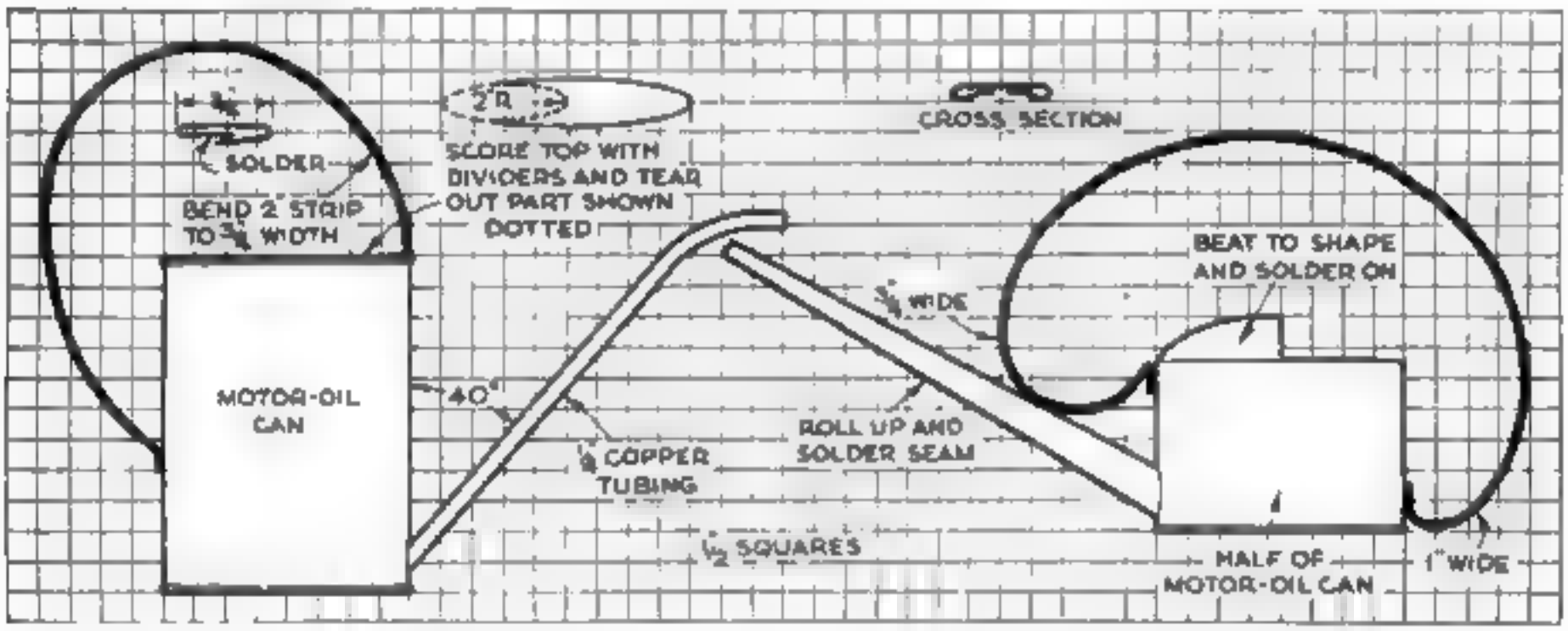
Inside dimensions may be as small as practicable just so the extinguisher may be removed quickly. Four 4" iron rods, or similar brackets, set in the sides about 4" above the floor will hold the unit. Under them should be mounted a 3" conduit box and receptacle for the lamp, which will then throw its heat upward and thus keep the entire cabinet warm. During a protracted freeze, or in subzero weather, the lamp should be kept burning continuously.



Dainty Sprinklers Made from Oil Cans

WHEN plants are brought indoors for the winter, you will want one of these sprinklers made from regulation motor-oil cans. The larger one, built from an ordinary quart container with the top left on, holds enough water for several pots. For the opening in the top, score the metal deeply with dividers and tear out the unwanted part with pliers. Punch a hole ⅝" from the bottom on the opposite side for soldering on the 9⅛" spout, which can be made from a discarded auto gas line, any ¼" tubing, or a strip of tin-can metal rolled up and soldered. Cut a strip of the metal 2" by 15" for the handle, bend it as shown, solder the seam, and solder it to the can in two places.

The smaller sprinkler is made similarly except that only half of a can is used and the top is soldered on. It will be found convenient for small pots or a miniature indoor garden.



NOVEMBER CHECK LIST [*SHIPSHAPE HOME*]

1. Inspect radiators for leaks and repair them with iron cement.
2. Drain a hot-water or steam system and refill with fresh water.
3. Scrape and cement joints in the fire pot of a hot-air furnace.
4. Repair or replace defective furnace grates.
5. Clean soot from the nozzle and burner unit of an oil-heating system.
6. Renew deteriorated smoke pipe from furnace to chimney.
7. Clean out scale and soot in boiler and tubes.
8. Insulate between chimney and wood framing with mineral wool.
9. Cut off water from all outdoor fixtures, such as sill cocks, and drain them.
10. Calk all cracks in the basement where air leaks in.

POPULAR SCIENCE MONTHLY SHOP DATA

For Pocketknife Whittlers . . .

ROCKING-HORSE BLOTTER

Is Fun to Carve

By ELMA WALTNER

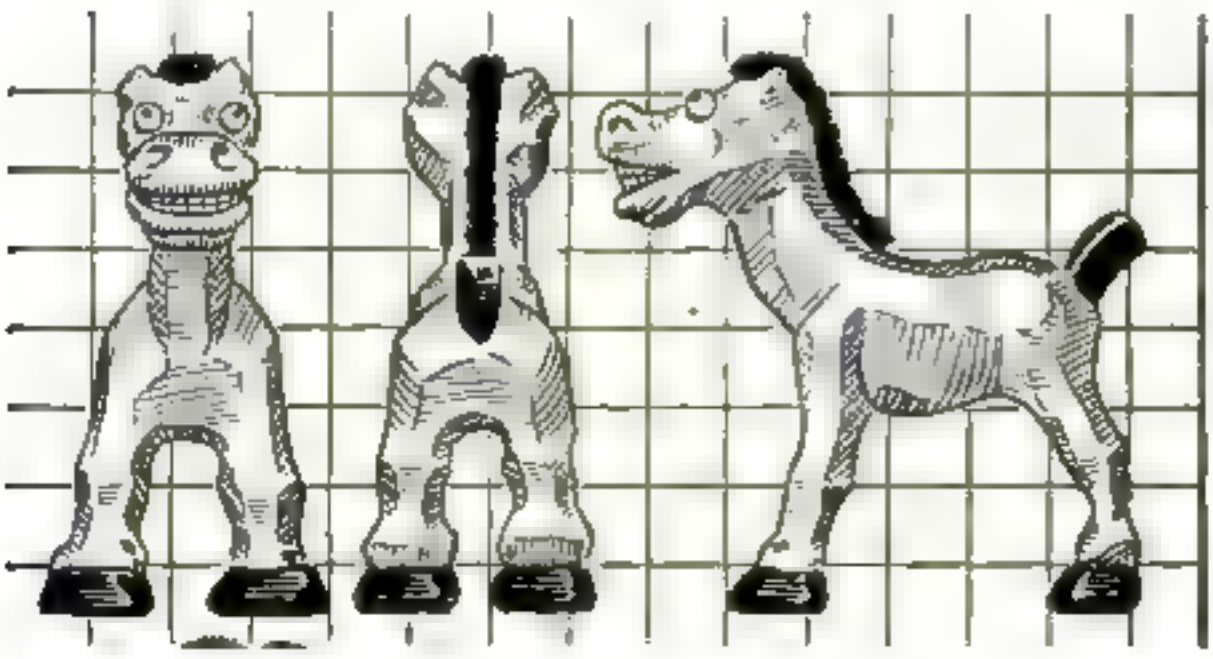
MEET Hector Hobbyblot, a wooden (but not Trojan) horse whose happiest moments are spent riding hobby-horse fashion on unblotted ink or in standing stanchly atop a stamp box. A jack-knife job, Hector is well within the capabilities of inexperienced carvers.

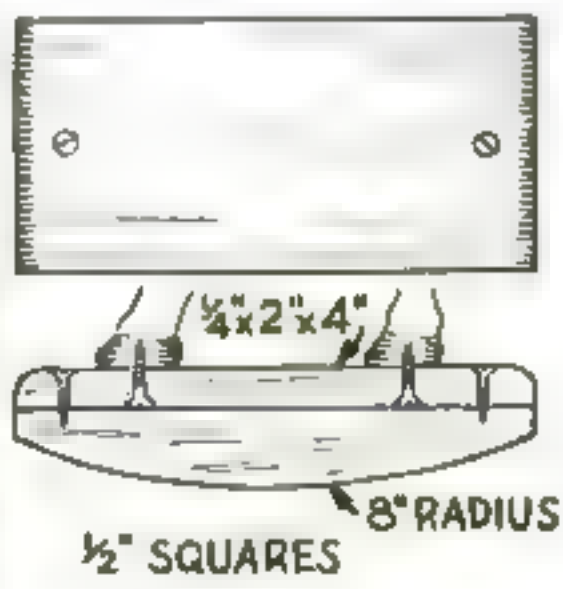
Use any kind of wood you prefer, so long as it's easily worked. Lay out the profile pattern on a piece of 2" stock, with the grain vertical to give sturdy legs. Then cut out the profile and drill two or three holes between the front and rear legs to help remove extra wood.

The carving is done entirely with a sharp knife. Don't try for fine detail, since the angles and planes add to the attractiveness of the piece as well as making the carving easier. To insure proper proportioning, turn the work often in your hands and rough out the entire figure before finishing any part. Use sandpaper sparingly to preserve planes.

Finish all but the teeth with shellac; they are a gleaming white, with markings added by pen and India ink. Hector's eyes are white map pins painted with black pupils. His crowning glory, his coal-black mane, is achieved by drilling a row of small holes in his neck and gluing in tufts of black yarn.

For a blotter base, cut one piece of stock ¼" by 2" by 4" and one ¾" by 2" by 4". Round off the ends of the thinner piece and mount the figure on it with four small countersunk screws running from the underside to each hoof. Drill the hoofs first to prevent splitting. Shape the lower section of the base to a curve of about 8" radius and attach with two small screws running down from the upper section of the base. Use strips of blotter cut 2" by 6". If you wish, Hector and the upper portion of the base may be mounted on a stamp box.



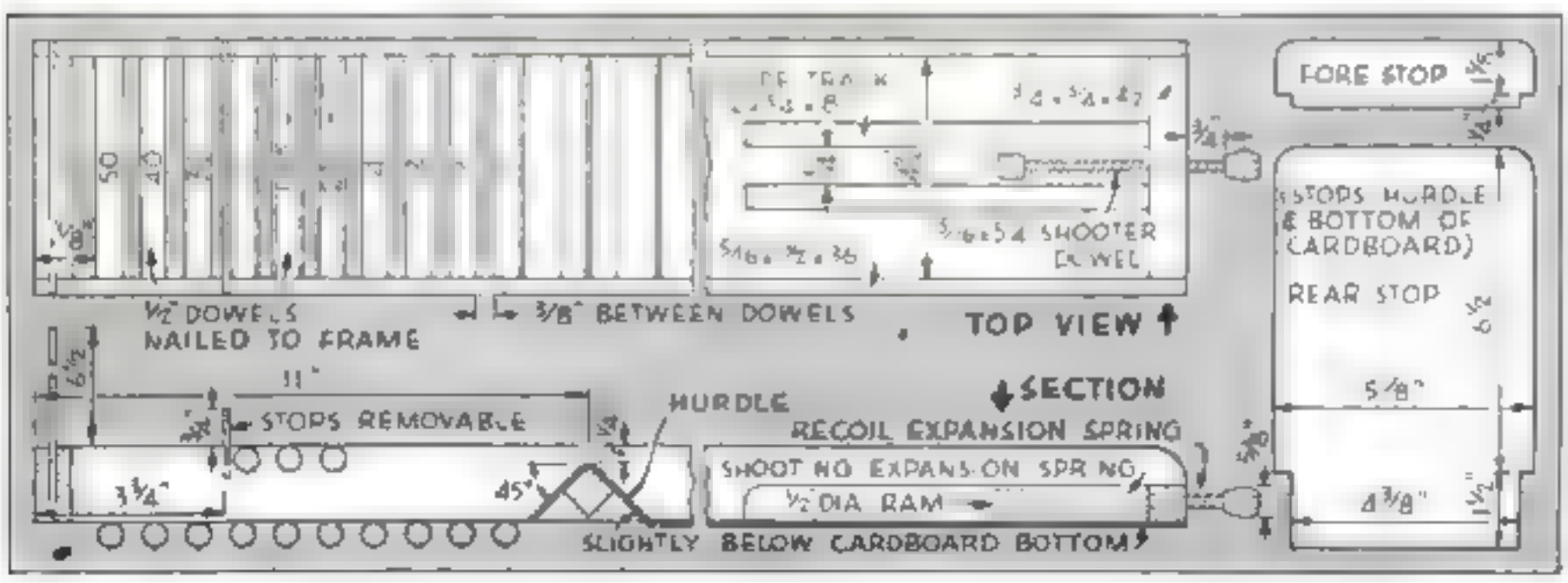


Test Your Skill with This New Double-Deck Skip-Ball Game

IF YOU pull the shooter back just right and release it with a steady hand, your first count may be 200. But if your technique falters, your next count may be a lowly 5. The game is played by shooting balls against the hurdle with just the proper impetus to drop them between the high-scoring dowels. Your turn at play consists of five shots.

The dowel nearest the player, in the bottom row, is numbered 1. The next nine dowels are numbered, in order, 2, 3, 4, 5, 10, 20, 30, 40, 50. Each number refers to the space in which a ball may rest between it and the next dowel behind it. Dowel No. 50 is ¾" from the end of the box. The upper three dowels have two scoring spaces, the forward one counting 200, and the rear space 100. Scoring here takes practice and skill. The five balls are wood, ⅝" in diameter.

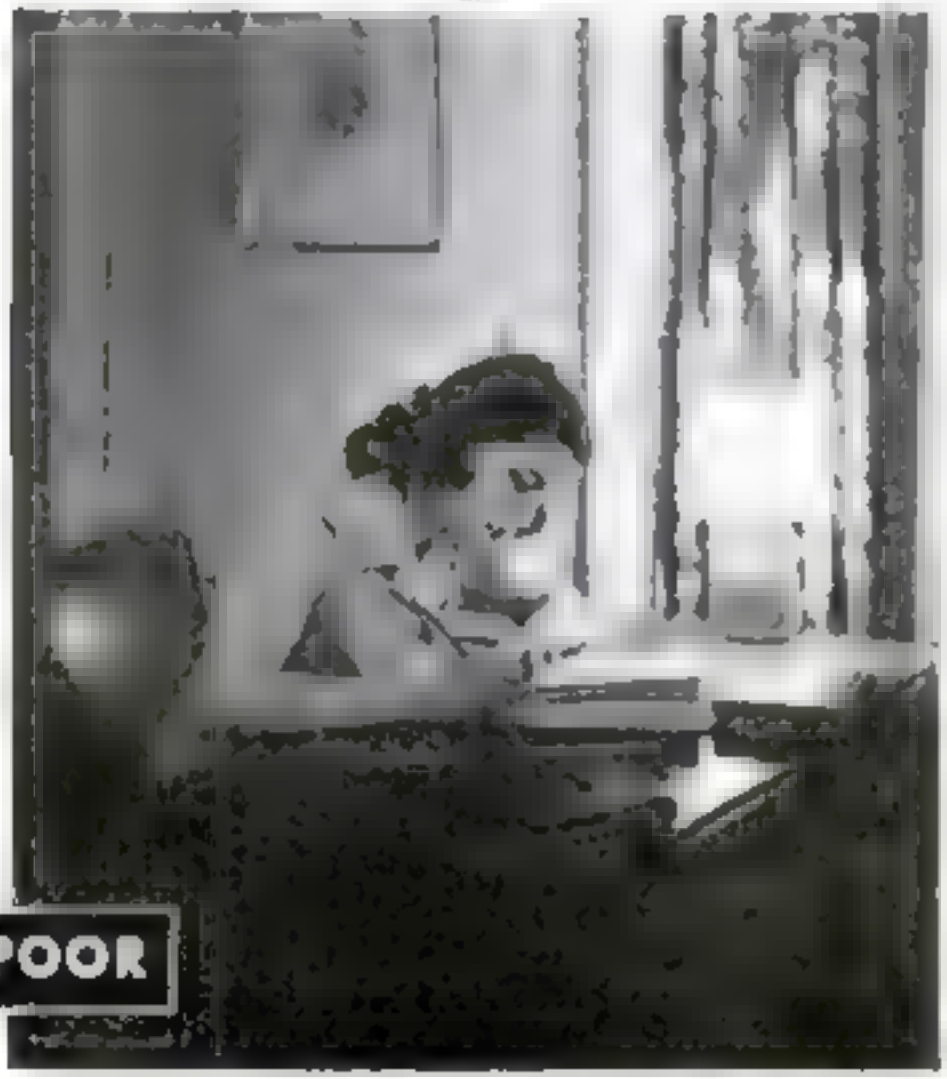
The model of the game shown in the photograph is attractively painted in five colors. The cardboard bottom and both removable backstops are blue. The sidepieces, the two backboards, and the hurdle are red. Bright yellow covers the guide tracks, front endpiece, shooter dowel, and 10 lower dowels in the scoring area. The top scoring dowels and the ram on the end of the shooting dowel are green. Scoring numbers are lettered in black on the upper surfaces of the scoring dowels.—MYRON FLEISHMAN.



HW 528

how to get

Better Light from Your Home Lamps



Poor lighting from a small lamp can be corrected very easily by adding an extension base and by replacing the shade. The extension shown above is made principally from a mailing tube

How raising the lamp and increasing the shade diameter give better light dispersal is illustrated at the right

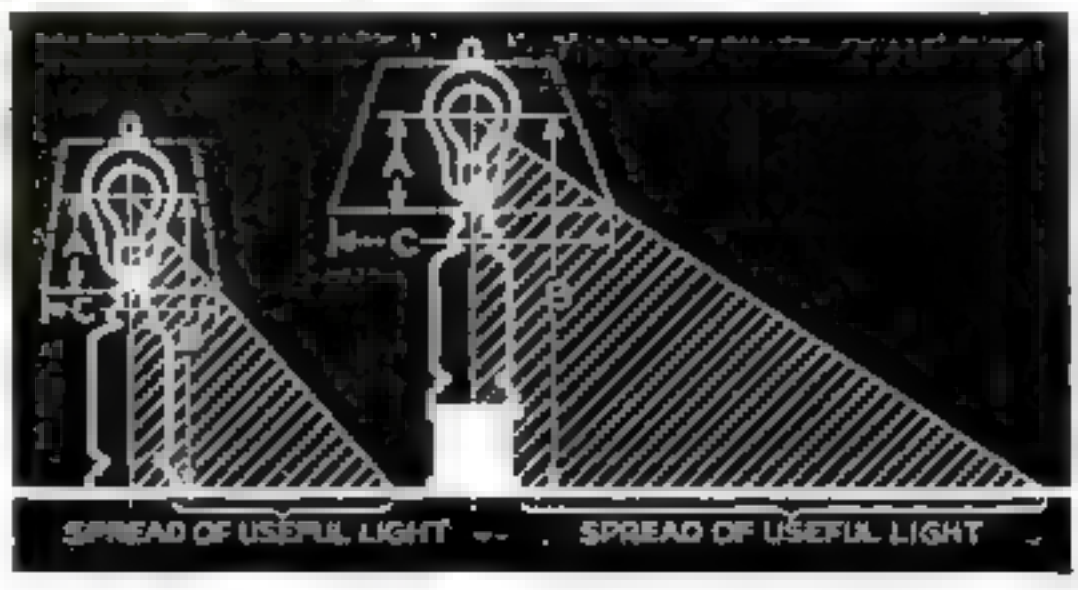
MANY a small electric lamp looks attractive in the store, but when you sit down to read or work by one, you may find that it is better to look at than to see by. Often the lamp is too stubby and the shade too small for proper lighting. Instead of discarding the lamp or putting up with poor light, specialists at the General Electric lighting research laboratories advise, simply make an extension base and use a shade with better proportions. These two steps will result in a substantial increase in the circle of useful light.

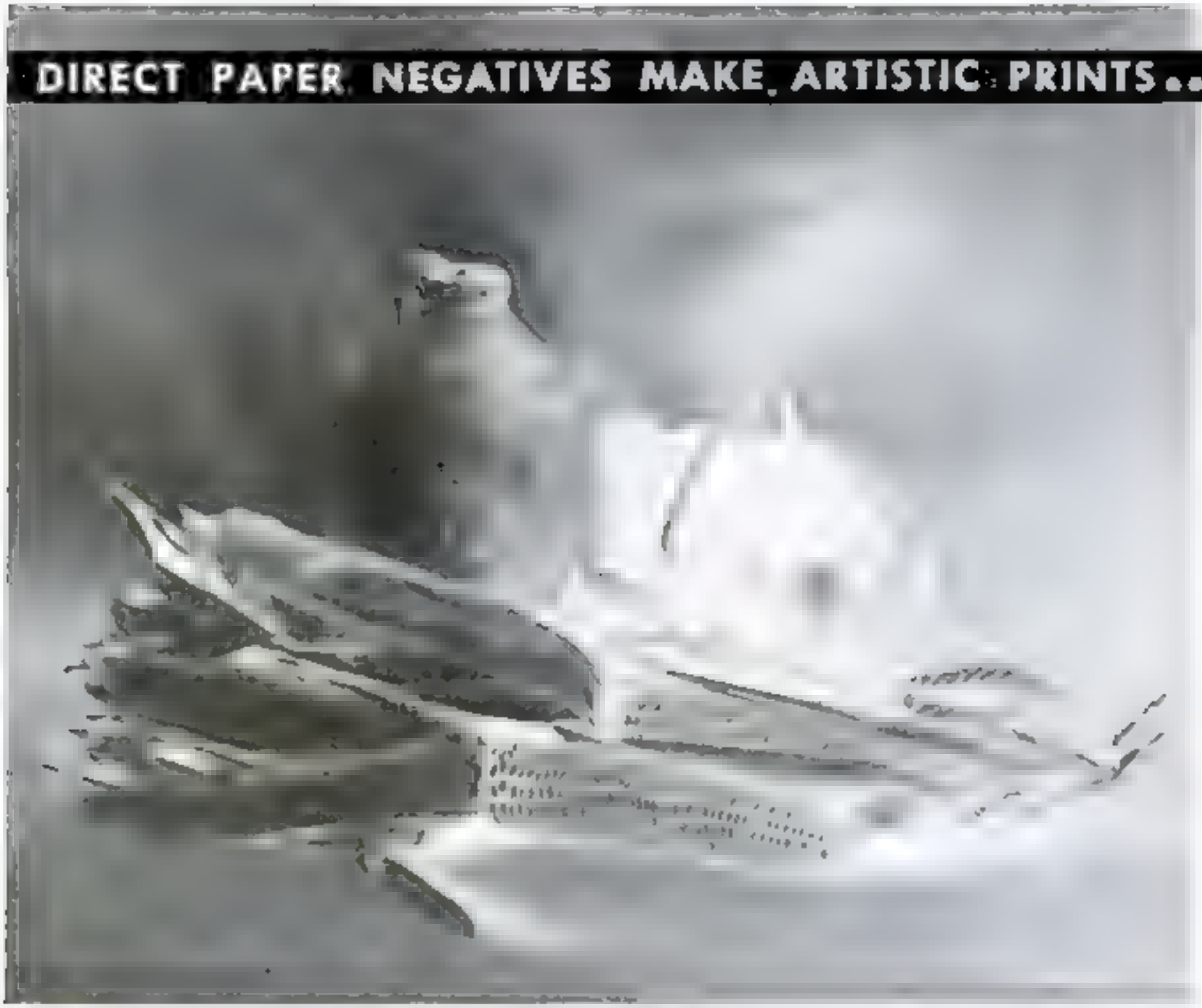
The extension base shown in the lower photo is a heavy mailing tube fitted with a turned-wood footing and filled with pebbles for weight. It has a cover recessed about $\frac{1}{2}$" to hold the bottom of the lamp. A small notch in the lip permits the cord to come out. An attractive extension base may also be turned wholly of wood in a design harmonizing with the lamp and bored all the way through for a wire entering at the bottom.

Lighting experts say that a single-socket table lamp, with its recommended 100-watt bulb, should afford comfortable seeing within a 24" radius of the base. Whether or not this coverage is achieved, however, depends upon dimensions *A*, *B*, and *C* in the drawing. A squat, tightly shaded lamp has a relatively small useful light circle.

If *B* is lengthened to from 13" to 17" by an extension base and *C* is increased by a larger shade, the maximum useful dispersal can thereby be obtained. *A* should be as small as practicable, with the lower edge of the shade, viewed at eye level, covering at least part of the socket.

To obtain efficient reflection of light, use a shade that is lined with white. It is also desirable to select one that is fairly dense so as to reduce direct transmission of light to the eyes.





This original negative was made with paper in the camera instead of film. An extra-thin grade of single-weight paper was used here

PHOTOGRAPHY

Filmless Photography

SHOOTING NEGATIVES ON ENLARGING PAPER IS GOOD FUN AND WILL BRING REAL RESULTS

EXPERT photographers desiring to produce highly artistic and dramatic photographs have long used the paper-negative process. This consists of making a positive print from a film and retouching it, and then making a negative paper print from the positive for further retouching, after which a finished photograph is finally secured by a print or enlargement made from the paper negative.

Without going through all these steps, and without using film at all, you can get just as fine results. You can make your first negative on enlarging paper in your own camera, and work directly on that, printing your final positive from this lone negative. It is a simple process and is a lot of fun. Enlarging paper is much cheaper than film, and by using it instead of film, you eliminate expensive waste on questionable shots and can also make a lot of pictures you might otherwise pass up because of the cost.

And not to be overlooked is the opportunity to do really thorough and artistic jobs of retouching. Working on a paper negative, the camera enthusiast has a chance to try many effects, rubbing out those that prove least desirable, altering high lights and shadows, and finally bringing the nega-

Either contact prints or enlargements may be made from the paper negative, which may be retouched for special effects

By KONRAD CRAMER

with Your Own Camera

tive to perfection, confident that erasures, pencil marks, and the like will not show up on the finished print.

Probably still more satisfying is the fact that you can know the results of your picture taking within a few minutes of snapping the shutter, for the whole photograph is unfolded for you as you develop the paper negative. As soon as it is dry, if the shot was a good one, you can begin retouching the paper negative to bring out desired effects, and then print your positive photograph from this negative.

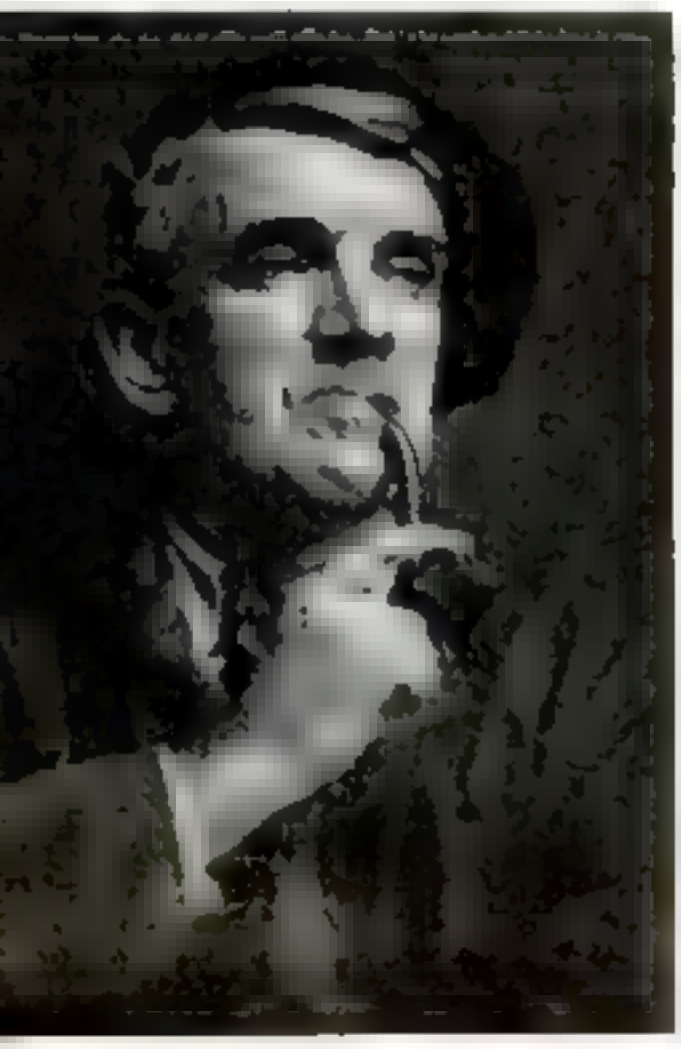
To use this type of direct paper negative, cut the enlarging paper to fit in the back of your camera. Loading is similar to that of plate or film-pack cameras, but only one paper negative can be loaded at a time. If you have a roll-film camera, cut the paper for single negatives and load as you would for the other types. It is not always necessary to do the loading in a darkroom, but a subdued red-orange light is essential.

For best results in taking these pictures, use single-weight, soft paper and expose it under strong light. The larger-size cameras, 3¼" by 4¼" and up, are ideal for this method. For my own purposes, I use lightweight paper in an 8" by 10" studio camera with which I can get a negative that requires no enlarging. Add to your equipment two or three photoflood lights, and you can make portraits of unusual quality if you can find a model who will hold still for 10 to 15 seconds. This exposure is usually necessary to get a good paper negative. If a comfortable pose is selected, most people can sit still that long with little trouble.

Still life is ideal material for direct paper negatives. Landscapes, with or without

Dramatic silhouettes with high lights and deep shadows for both figures and background, as shown in the photograph above, are created by retouching both sides of a paper negative before it is contact-printed or enlarged as desired

Portraiture of distinction is possible on paper negatives if the subject will hold a pose for as long as 13 seconds



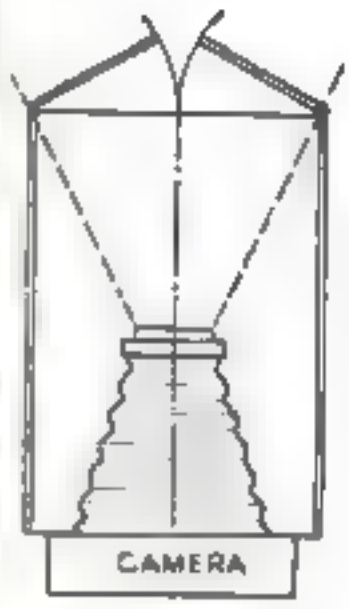
figures in the foreground, are also good. Sometimes you will find that the negative itself has great pictorial charm. In such a case, there is nothing to hinder you from mounting and exhibiting a negative.

The paper negative can be retouched on both sides, using a ground glass and light when working on the back. Light tones, modulations, and additions may be added by building up the wanted values with any soft pencil or crayon and then shading with a stump. Large areas may be handled with a bit of chamois and powdered crayon. Dark tones and accents in the final print can be produced by lightening parts of the negative with local reducer or by carefully rubbing them down with powdered pumice. Major blemishes and faulty backgrounds can thus be corrected.

Some photographers using this process content themselves with only a slight softening of the image, caused by the printing light having to penetrate the paper instead of transparent film, plus a few slight retouching corrections. It seems best to go easy in the beginning so that most of the original character of a photograph is retained. Overworked paper negatives may take on the final appearance of a poor drawing, a result that is to be avoided.

Paper negatives can be enlarged or contact prints made from them. Extra-thin paper should be used in the smaller cameras as it gives a very pleasing texture effect when enlarged. The general effect of the enlargement is diffused, in contrast to the sharp definition of contact prints, yet the enlargement often has simplicity and distinction.

The writer made an 8" by 10" cardboard camera, using an ordinary magnifying glass as a lens, two cartons telescoping into each other, and a piece of ground glass which is interchangeable with a printing frame. If you make up such a camera for yourself, you'll be set for some inexpensive and distinctive photography, for paper negatives afford many ways in which to achieve a controlled artistic effect.

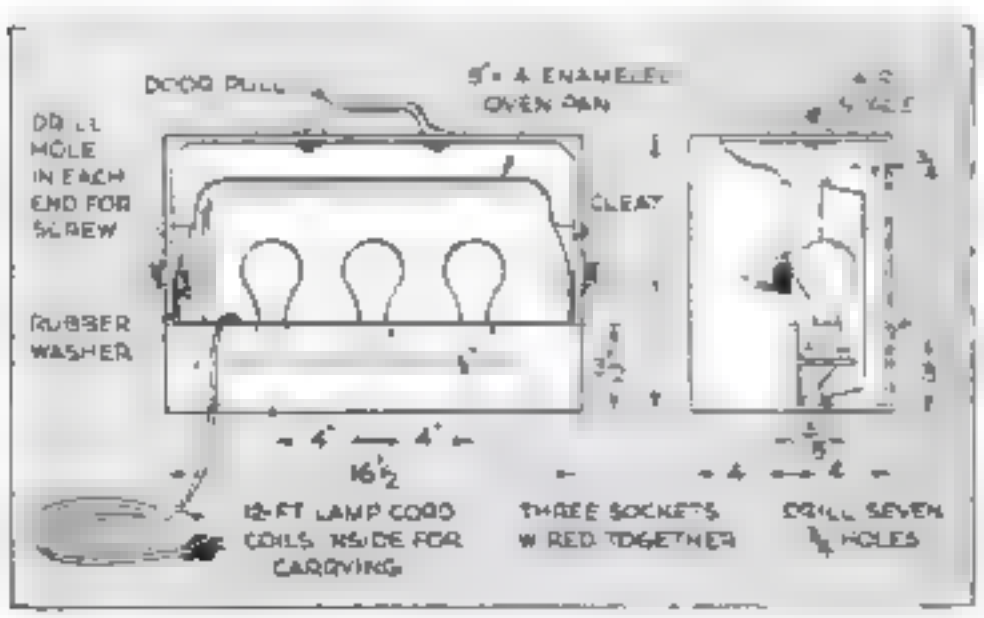


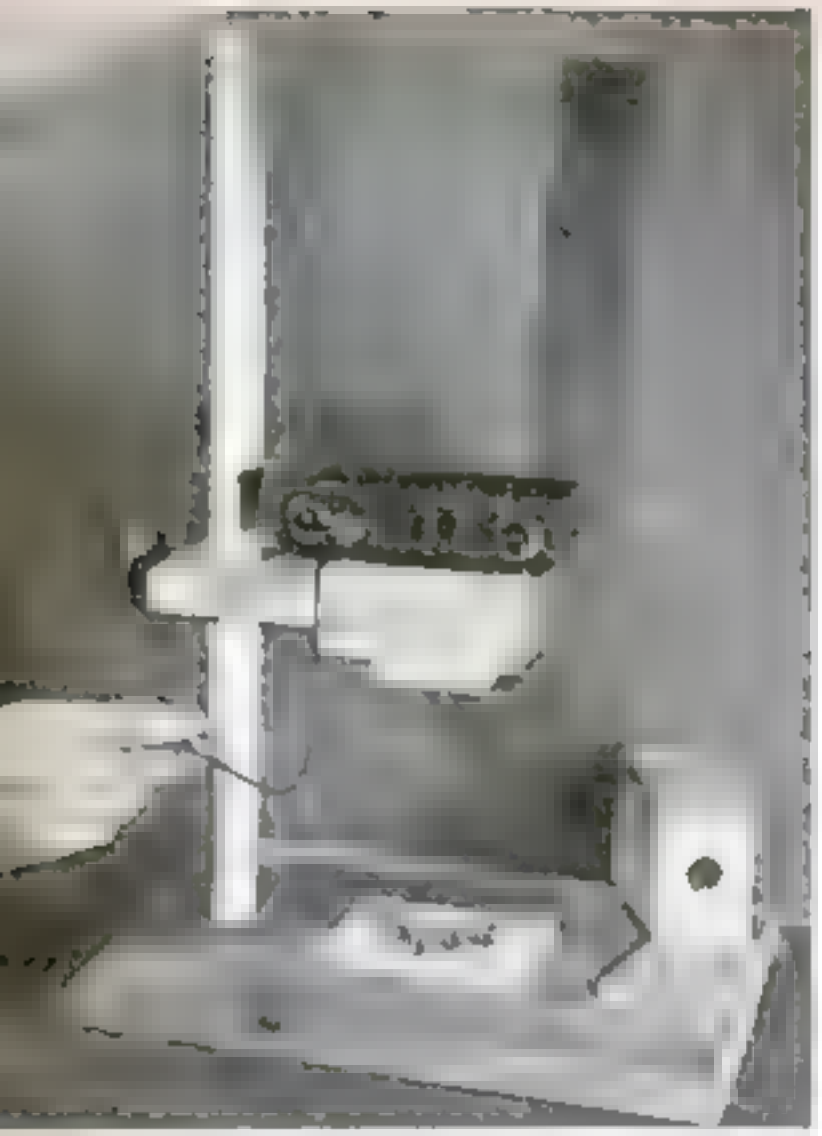
NIGHT AND DAY can be dramatically portrayed in the same picture by using a simple duplicator attachment. Build a box that can be secured to the front of your camera, fitting it with two vertical doors. Aim at a scene that will afford interesting day and night contrast and take, say, a daylight picture with one door closed. Leave the camera untouched until nightfall; then open this door and close the other to make a second exposure on the same film. With a film-pack camera, just block off half the film with cardboard inside the camera, and reverse it between shots.—LOUIS HOCHMAN.

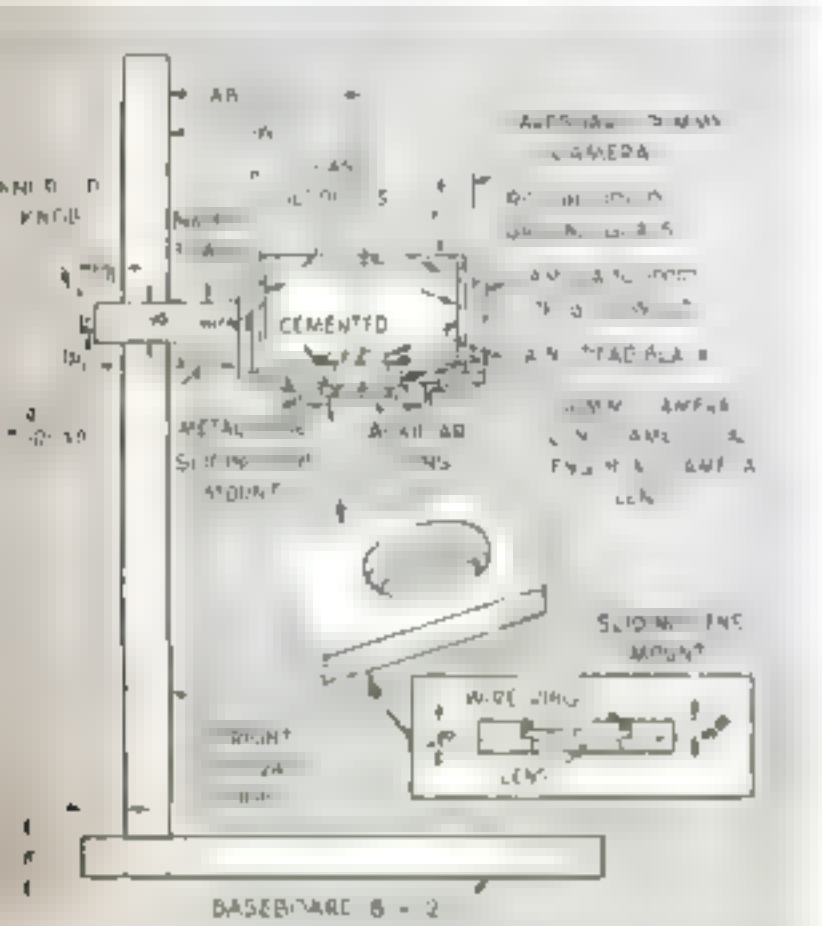
PORTABLE FLOODLIGHTS. Good indoor pictures require adequate lighting, particularly if color film is used. Shown at right is a compact case, only 8" by 11" by 16½", which holds six photofloods, complete with reflectors and extension cords. The case divides into two three-lamp banks of No. 1 photofloods which can be used separately on the floor or on tables or can be hung from picture molding.

As shown in the drawing, the cases are made from thin wood and the reflectors are ordinary white enameled oven pans, fastened to cleats inside each case. Sufficient air space should be allowed so that the cases won't get too hot. Air holes are cut behind the pans to provide ventilation.

In using the outfit, remember that six No. 1 photofloods will load a 15-amp. circuit to capacity. The 18-gauge extension cords should always be plugged into wall outlets, never into lamp sockets.—PAUL KOMROFF.







DUMMY CAMERA

Focuses Copying and Close-up Shots

AN INGENIOUS copying and close-up outfit, especially suitable for roll-film cameras which lack ground-glass focusing, may be built of wood scraps, a ground glass, and two lenses.

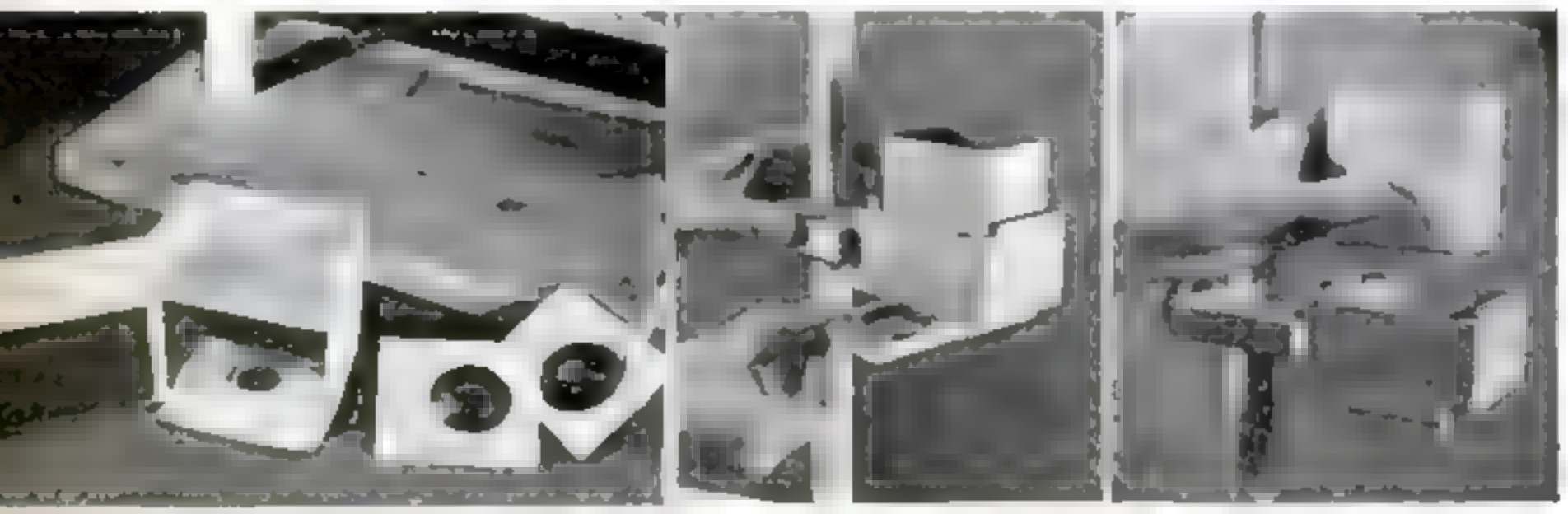
The principle is simple. A vertically sliding camera holder contains a supplementary lens, while a cardboard dummy camera has a lens of the same focal length as the camera lens. The dummy camera, which has ground glass instead of film, is used while adjusting the camera holder to sharp focus, after which the real camera is put in position and the picture snapped.

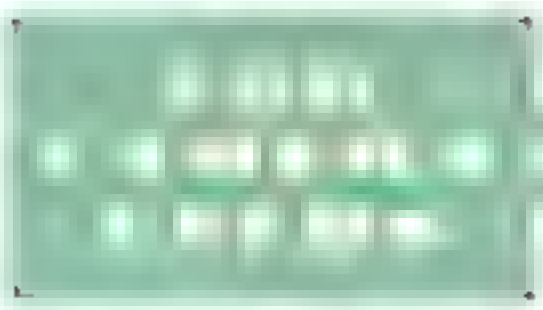
Design the camera holder so that the camera will always assume the same position when laid on it. The supplementary lens may be a regular copying or portrait attachment, or one of the chipped-edge lenses now available at low cost.

Make the dummy camera out of cardboard, proportioned so that its lens, when the dummy is in the camera holder, occupies precisely the position which the real camera lens would occupy. The lens in the dummy need not be of high optical quality, provided that its focal length approximates that of the camera lens. Mount a piece of ground glass in the dummy at the plane of sharp focus for objects more than 200' distant. The camera field may be located on the ground glass in this manner: Put a piece of ground glass (rough side down) on the film aperture of your camera, focus at infinity, and then put the camera in the stand. Adjust the height until a sheet of newspaper tacked to the easel is in sharp focus and note the area covered. Then put the dummy in place of the camera and mark the same field on the ground glass.

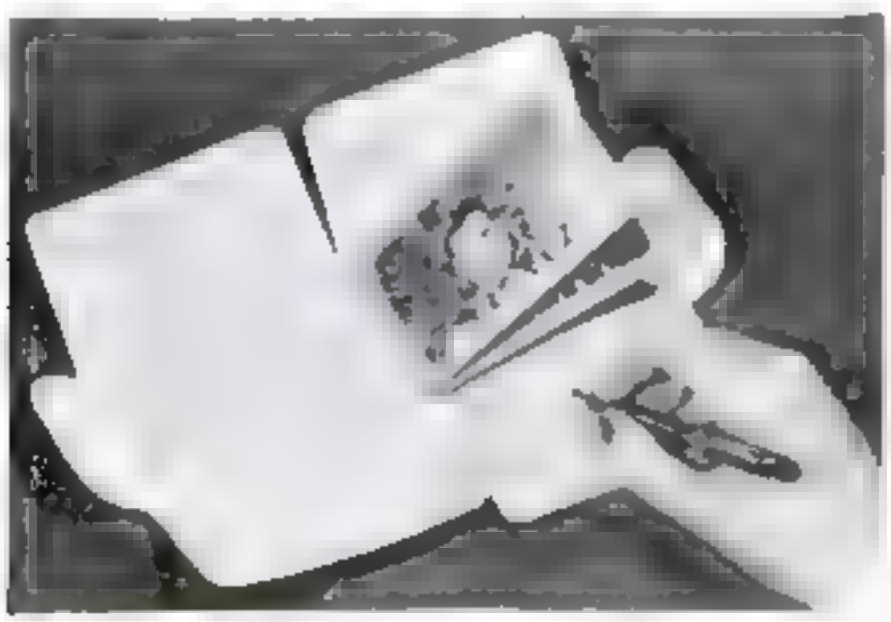
To take a picture, focus with the dummy camera and supplementary lens in the holder. Replace the dummy with the real camera, which should be focused for infinity and stopped down to f/16 or f 32, and make the exposure.—ERVIN WALTERS.

The cardboard dummy camera, below left uses a lens with a focal length equal to that of the lens in the real camera. Note that the field limits are indicated on the ground glass. The other pictures below show how the supplementary lens and dummy are inserted in the holder. Different auxiliary lenses may be used





LETTER ALBUMS which combine space for six snapshots and two 4¾" by 8" writing surfaces are now on the market. Excellent for sending photos to service men, the folded letters protect pictures in transit, and may be used on receipt as pocket albums.



EXPERIMENTAL LENSES of different focal lengths and diameters may be bought in sets priced so that a single lens costs but a few cents. Though ground and polished, they are inexpensive because small chips on the edges make them commercially unacceptable. They may be used as supplementary lenses for close-up or telephoto work and for making ground-glass or enlarging focus magnifiers, color-film viewers, and telescopes. Instructions come with the sets.

PORTABLE DARKROOM equipment, compactly arranged in an easily carried case, is now being made for the armed forces. Similar models are planned for postwar civilian use. Besides chemicals, paper, trays, and a daylight developing tank, the case holds a timer, safelight, thermometer, easel, and an enlarger that can be powered by a car battery. It also has space for a camera, flash synchronizer, and filters.

HOT-WEATHER DEVELOPMENT of films is said to be easier and safer with certain new chemical solutions. Films can be processed in temperatures that range up to 100 deg. F. without risk of softened emulsion or reticulation. The temperature-resistant solutions include developers, hardeners, and fixers. Photographers working in hot weather in temperate zones, those in the tropics, or those using makeshift field darkrooms will find the chemicals of special value.

Special Jigs and Attachments
ADAPT
Your Bandsaw
TO MANY USES

By EDWIN H. LOVE

HOMEMADE attachments and jigs will greatly extend the uses to which a small bandsaw can be put. They make possible accurate cutting of tenons, automatic sawing of irregular curves, thinning of stock for bending around forms, and other types of jobs.

What is a setup for cutting tenons? First cut the cheeks, or sides, of the tenons. To guide the work, clamp a piece of straight square stock to the table for a fence parallel to the line of sawing. This fence must be high enough to support the work accurately with the face side in a vertical plane. The distance from the fence to the saw blade is such that the kerf will be made in waste wood with its far side forming the tenon cheek. This distance should be established by making trial cuts in scrap wood Clamp a block to the fence where it will stop the forward motion of the work when the cheek is cut to length.

With this setting, saw one cheek of all like tenons, sliding the face side against the fence. If the pieces have parallel edges, they may be turned end for end, with the face sides kept against the fence. The position of the stop block is shifted if the tenons differ in length.

If the pieces are equal in thickness, their opposite sides may be put against the fence when the other cheeks are sawed, but if the thickness of the stock varies, such reversal will make the tenons either too thick or too thin. In this case, the fence should be reset to keep the face sides of the pieces against it. Shifting of the fence can be avoided if it is first set to cut the cheek opposite the face side. Then a shim of proper thickness may be inserted between the fence and work for sawing the face cheeks.

To cut the shoulders, as shown in one photo and in the sketch, clamp a stop block to the table at right angles to the blade. Also clamp on a length block to locate the tenon ends. Rest the piece to be cut on edge, rock the upper edge toward the stop block, and slide the lower edge forward until the blade severs the waste. As

before, use test cuts when setting the blocks, and make allowances for variations in stock thicknesses.

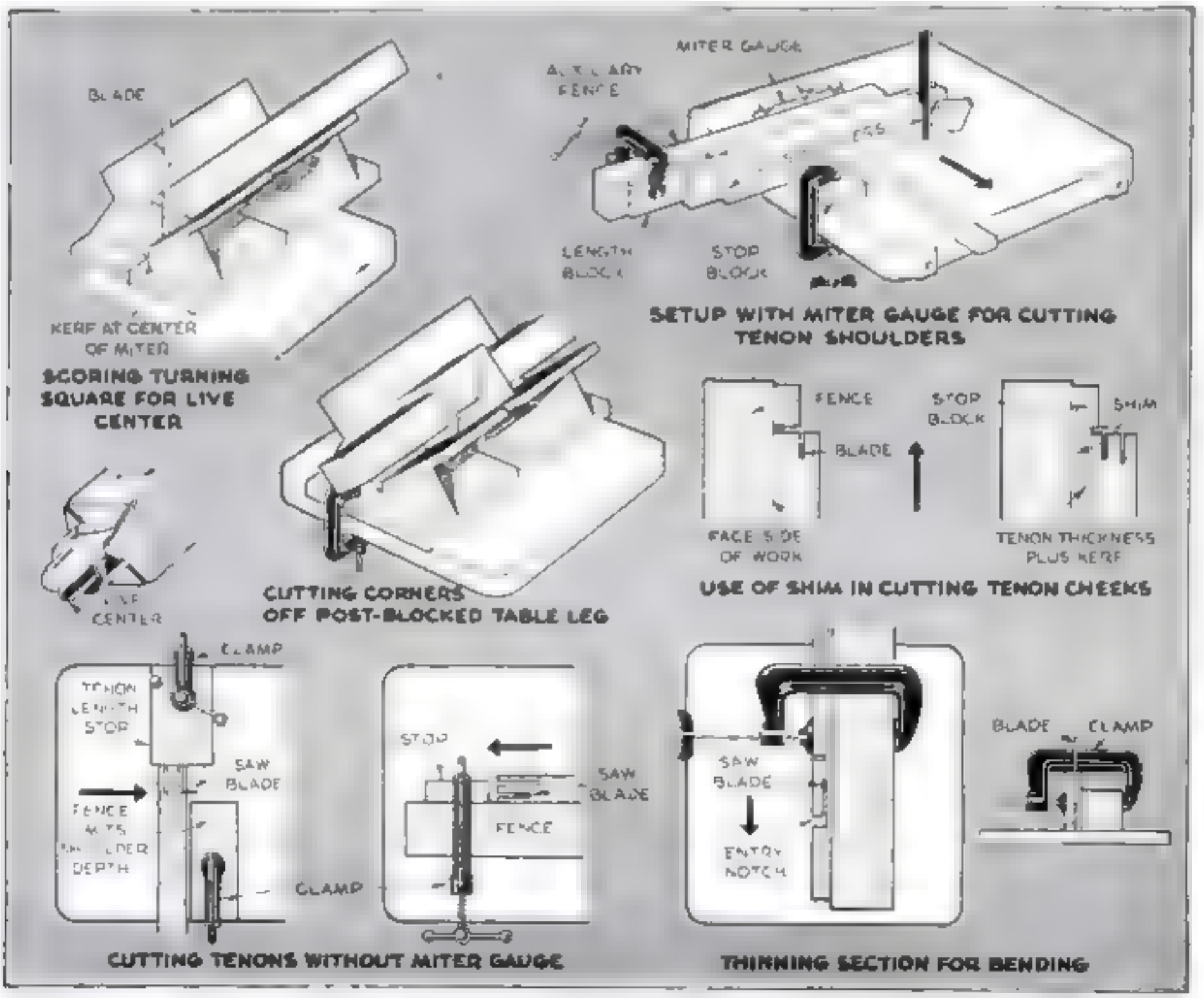
These methods apply only to comparatively short stock cut to exact length. Trim the tenons to width with similar setups, but with the face sides lying on the table. Trim the shoulders freehand or use the miter gauge.

When through tenons are made, cut the pieces roughly to length and use shoulder stops to locate the shoulder cuts for the second tenons after the first ends are cut. This assures accurate shoulder-to-shoulder measurements and correct frame dimensions after assembly. It is a good method to use even when the stock is precut to length. If the bandsaw is equipped with a metal fence, screw a larger auxiliary fence to it so as to give a firm support when wide work is handled.

Of what use is a trough jig? This is a jig in which a piece of square stock can be supported cornerwise with the diagonals vertical and horizontal. The construction is shown in the drawing. Make a center kerf at one end and notch one side. A typical use of this jig is in scoring the ends of a turning square to give bite for the live center of the lathe. Clamp the jig to the table with the blade in the end kerf and feed the turning square against the saw, cutting about 1/16" deep. Turn up the other diagonal and repeat.

With the same jig clamped to the table so that the blade enters the wider side notch, it is possible to trim off the corners of built-up table legs. This saves turning time in roughing down the bulbs on post-blocked turnings and the like.

How is part of a rail sawed thin? Clamp the work to a heavy squared piece. Notch the inner face where the bend is to begin and make a kerf at the end. The slot can be made with several bandsaw cuts and a sideward motion to break out the waste. The blade is then entered to rip out the required portion. Cut the thin section an extra ½" long to allow wedges to be driven in for tightening. This method of clamping the piece to a heavy squared piece of stock is useful on many jobs since it gives ade-



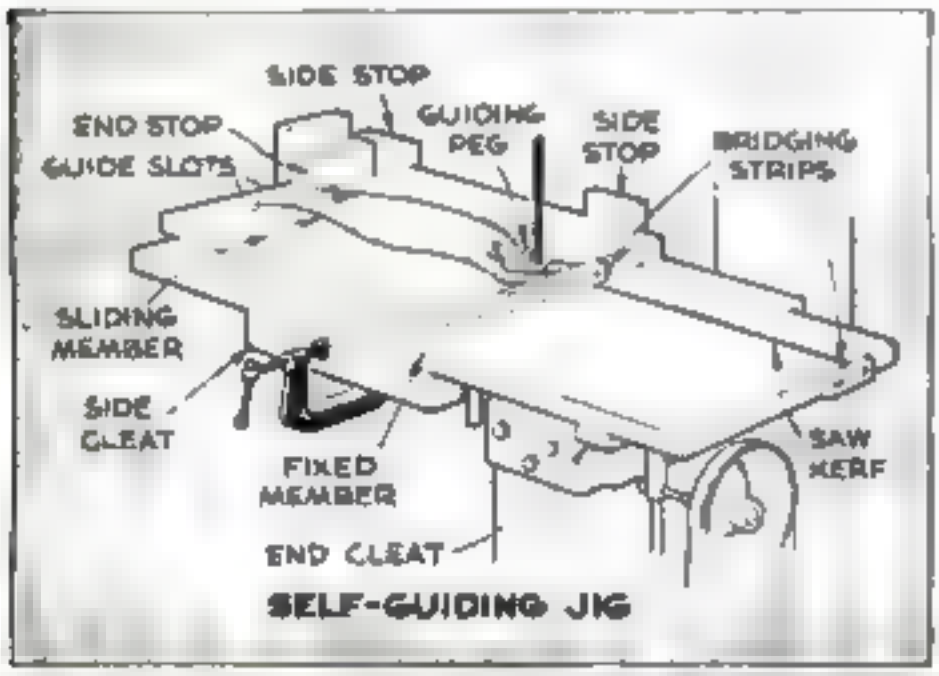
A rail being thinned to allow bending is clamped to a 3" by 4" piece permitting freehand guiding

Accurate shoulder cutting is assured with stop and length blocks to control the depths of tenon cuts

quate support when freehand cutting is done.

What can be done to correct saw-blade lead? If the blade doesn't lead true, it can often be improved by holding an oilstone lightly against the side to which it leads while the saw is running, thus reducing slightly the set of the teeth on that side. A little lead is of no consequence in freehand work, and the fence can be quickly adjusted for ripping to make it parallel to the line of cut, but when a miter gauge is used, difficulties due to wedging may be encountered. Sometimes this can be corrected by loosening the table mounting screws sufficiently to allow the table to be swiveled by light mallet taps on one corner.

How are self-guiding jigs made? The drawings illustrate a basic type. The size depends upon the design to be cut. The lower, or fixed member, has cleats beneath it to locate it on the saw table, and it has a saw kerf to allow entry of the blade. Set a guiding peg in the fixed member in front of the blade, and if the curve to be cut allows, add another peg behind the blade. The

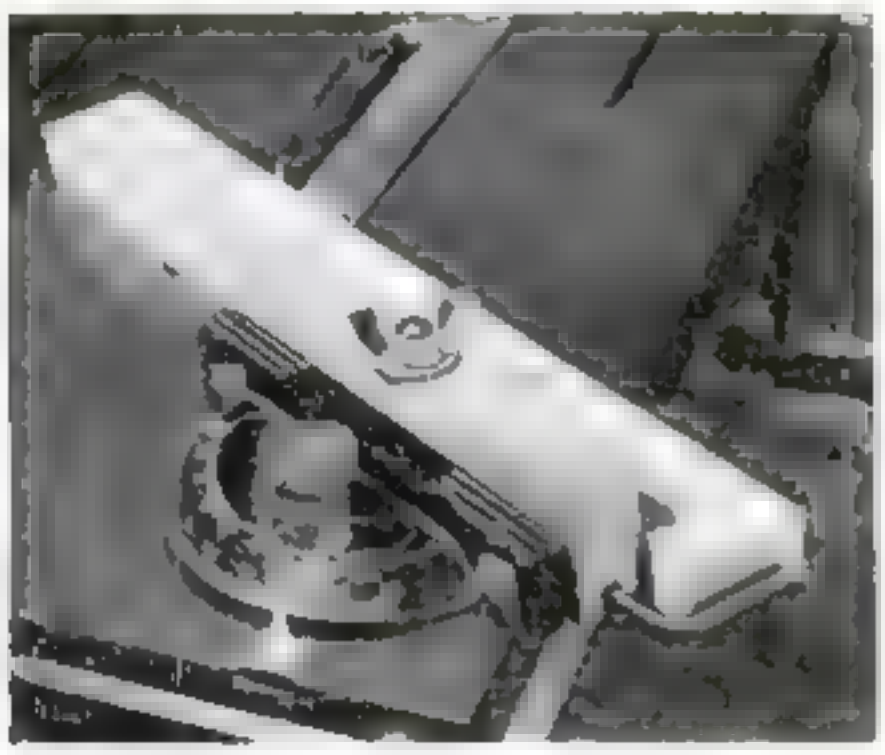


SELF-GUIDING JIG

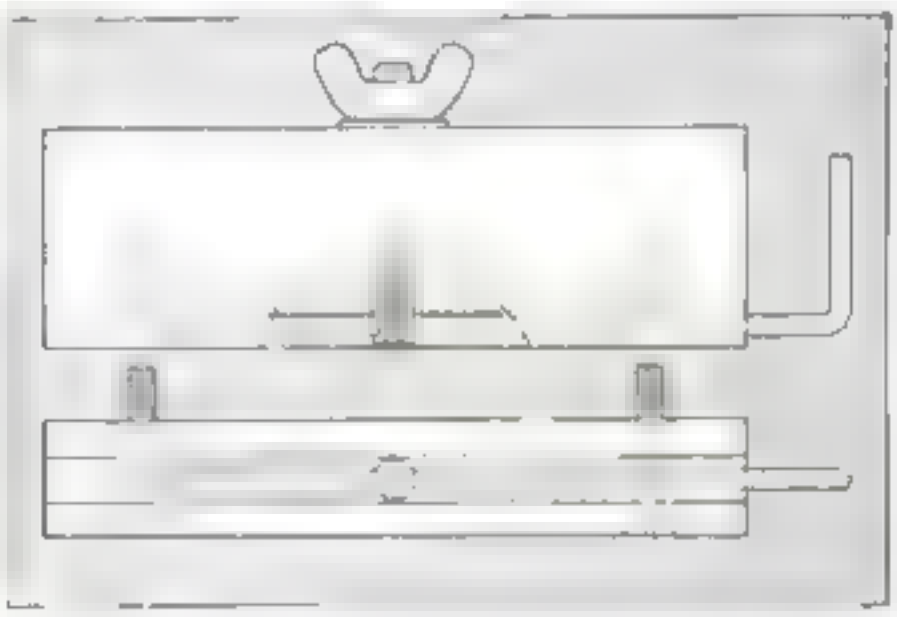
At the left is a sketch of a jig for sawing several layers of plywood at one time. Before cutting, make sure all pieces are up against the stops. A sliding pin guides the work as it is sawed, thus eliminating layout and producing accurate work at the same time

upper member of the jig is a sliding form with one or more guide slots cut in it. These must be accurately made, with no more than free sliding clearance on the pegs, and they must be long enough for the blade to run free in front of and behind the parts to be cut. Screw on stop blocks, as detailed, and also hardwood bridging strips to stiffen the slit ends of the jig members. Place the stock to be cut against the back and side stops of the sliding member and push forward until stopped by the peg.

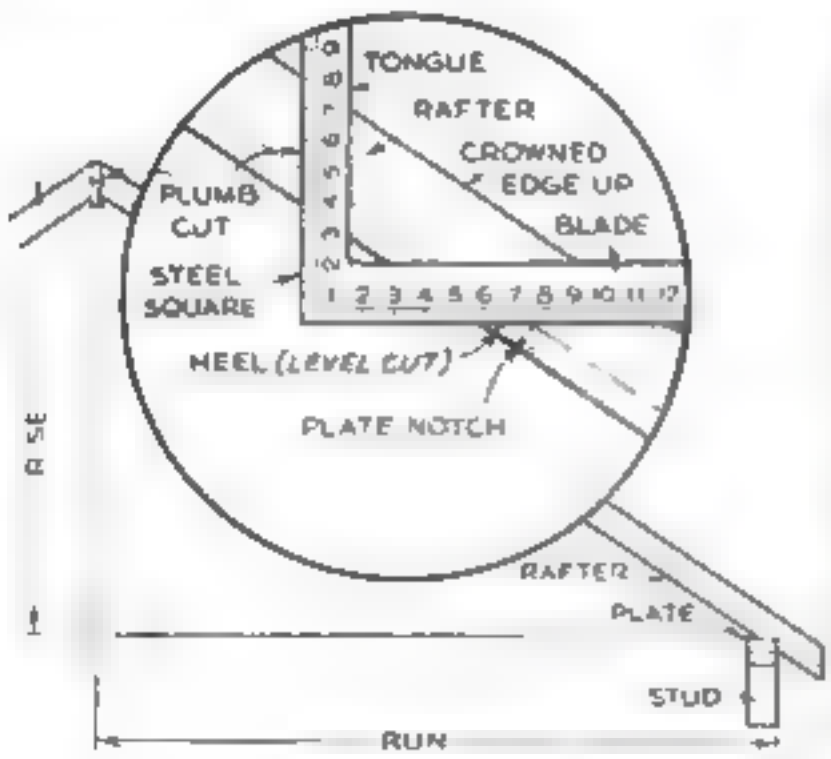
Stop Rod Prevents Creeping of Miter Cuts on Circular Saw



MAKE a ¾" hardwood block as long and as high as the face of the miter protractor. Set two countersunk bolts in one side of the block, with nuts set flush on the other side. Let the bolts extend ¾" to go through holes in the miter gauge, where they are attached with two extra nuts. Cut a groove in the bottom of the block for the stop rod. A vertical hole takes a bolt having a hole drilled through its lower end to let the rod slip through. When the wing nut on the upper end of the bolt is tightened, the sliding rod, with a right-angle bend at the end, is locked and holds the work from creeping. If you make rods of various lengths, you can handle many sizes of work.—B. B.



BRACES AND COMMON RAFTERS [SHIPSHAPE HOME]



The plumb and level cuts of a common rafter are determined by the rise and run of the roof pitch. The rise is the vertical distance between the plate and a point on the plumb cut which is located by extending a line along the rafter, parallel to its edge, at the depth of the plate notch. The run is the distance from the center to the outside of the plate. This is usually expressed in terms of inches rise per 12" of run. The sketch illustrates 8" in 12".

Lay the square on the stock with the figures coinciding with the crowned edge. A line drawn along the tongue is the guide for the plumb cut, and a line drawn along the blade is a guide for the level or heel cut.

The plate notch is usually cut 1" deep on the plumb for 2" by 4" stock. On wider rafters, cut deep enough to provide a 2" or greater bearing of the heel on the plate.

The same principle applies to cutting butted braces.

POPULAR SCIENCE MONTHLY SHOP DATA

Modern Cabinet Conceals

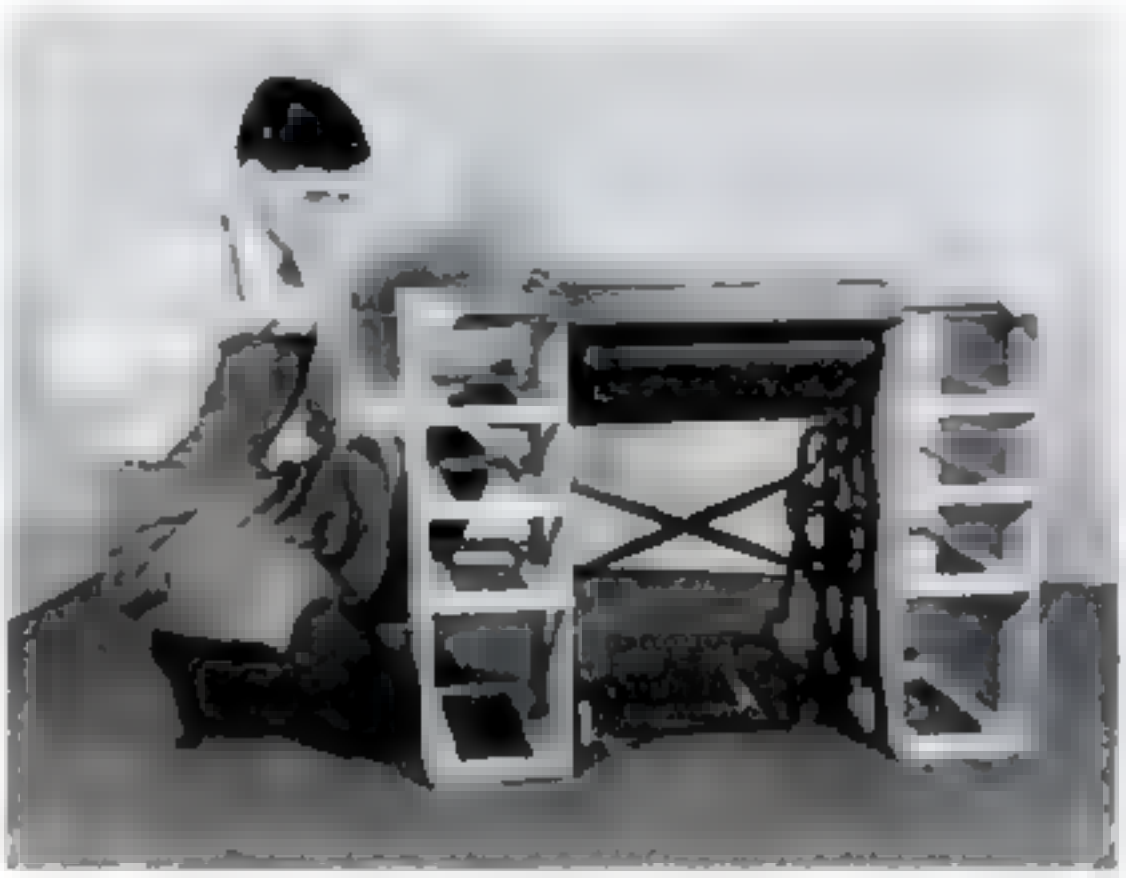
NEW DRESS PROMOTES IT

By Charles and Bertram Brownold

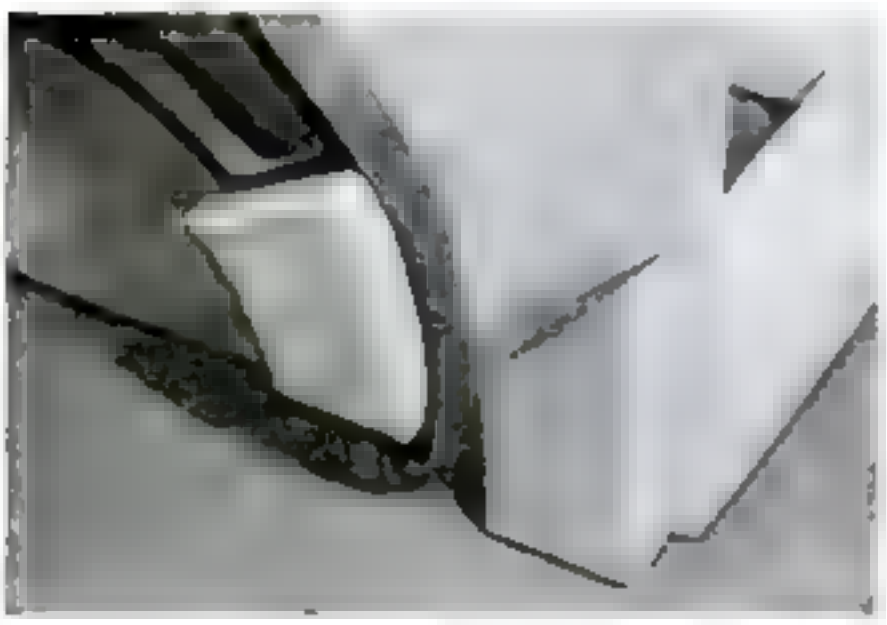
DUSTED off and rehabilitated, many old-fashioned sewing machines are doing yeoman work to help the family budget. With a new dress to hide ugly Victorian lines, yours may be brought out into the open where it will be easier to get at when there is mending to be done or new clothes to be made. The simple wooden cabinet shown can be made for any drop-head model

1 Wood extensions are attached at the sides and back of the machine top with the help of cleats

2 Use of a plumb line shows the back projects beyond the ironwork



3 Drawer cabinets of plywood attached to rectangular frames are screwed to the sidepieces and wooden parts of the machine



4 Corner blocks lock matching ones on a front panel, while others hold the cabinet to the frame

5 Sliding bolts made of hardwood dowels lock the top of this detachable panel to the cabinet

Old Sewing Machine

FROM ATTIC TO PARLOR

and will double as a living-room chest or desk, a dining-room sideboard, or a bedroom dressing table.

Discard the old drawers and attach a 2" by 3" piece to each end of the table, as in Fig. 1, rabbeting the inner edge to fit the routed edge of the top. Set the upper surfaces and ends flush and fasten on the underside with thin hardwood cleats, such as those shown in Figs. 1 and 2. The backs of the top drawers that will be installed later

6 These dowel bolts are screwed to the handles through slots in the panel that permit sliding

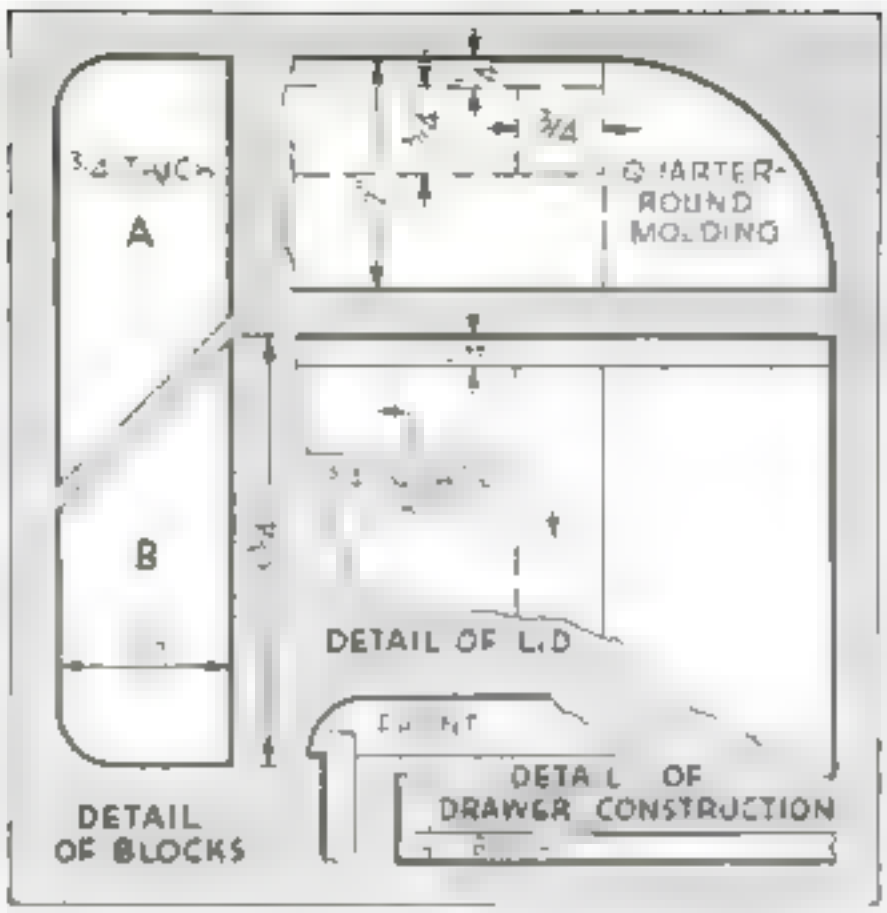
7 With its new dress completed, the old-fashioned machine becomes an attractive piece of furniture

Top and front panel removed and its dropped head lifted, the old machine does a good job of sewing

are cut down about ½" to allow them to slide past these cleats.

It may be necessary to attach similar extensions to the front and back if the metal frame projects beyond a plumb line held from the table edges (Fig. 2). On the machine used here, an extension was needed only at the back since all parts at the front were within the plumb line.

For each of the side drawer cabinets shown in Fig. 3, you need two ¼" plywood panels and four rectangular frames. These frames, of ¾" by 1½" stock, must be the same size and accurately squared. They have lap joints glued up under pressure The plywood panels are attached to them



Above the machine serves as a dressing table when not used for sewing, and at right as a desk. Some details that will aid in construction are shown in drawings at the upper right

with countersunk screws driven in from the outside

The inner panel of each cabinet is held tightly against the iron frame by fitted hardwood blocks at the bottom, as illustrated in Fig. 4, and at top it is fastened by screws to the woodwork of the machine. Openings should be cut in the plywood to accommodate any projecting parts of the ironwork. The outer panels are about 1" longer than the inner, and their upper ends are fastened with screws to the table-top extensions. One piece of plywood is fastened across the entire back of the machine.

Stock 1" thick is used for the drawer fronts, the sides of which are rounded off as shown in the photographs. The deep bottom drawers—spacious enough to hold both materials and work—have fronts made of two pieces so that when closed each appears to be two drawers. All the fronts are deeper than the drawers themselves, covering the frames upon which the drawers slide, and are wide enough to be flush with the cabinet sides. The bottoms are plywood glued into rabbets ¼" from the lower edges of the fronts, sides, and backs. Drawer pulls 3" long are made of 1" hardwood dowels flattened on one side and fastened with screws from the inside.

When the machine is not in use, the top is covered by a lid having pegs that fit into holes bored in the table-top extensions. The lid is made of ¼" plywood and quarter-round molding held together by ¾" strips, as shown in a drawing, and on the front is a 1" plywood strip concealing that part of the sewing-machine top between the two drawer cabinets.

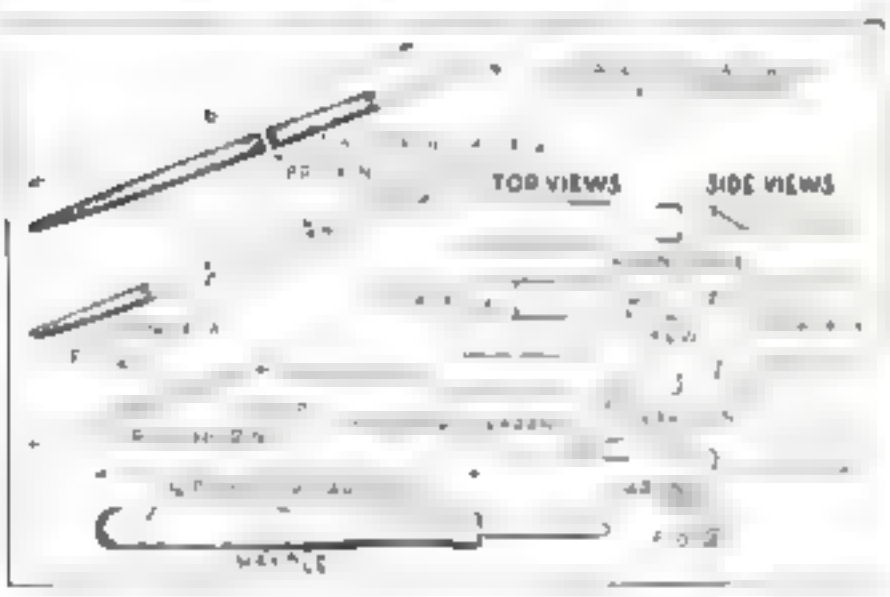
The treadle and driving wheel are kept from view by a plywood panel (Fig. 5) that is removable. Hardwood blocks near each lower corner of the panel and on the lower corners of the drawer cabinets hold this removable piece at the bottom (Fig. 4), while sliding hardwood bolts fasten it at the top. These bolts (Fig. 6) are made of 5" lengths of 1" hardwood dowels and are attached to handles on the outside with wood screws extending through slots. The bolts slide into holes bored in the drawer cabinet walls.

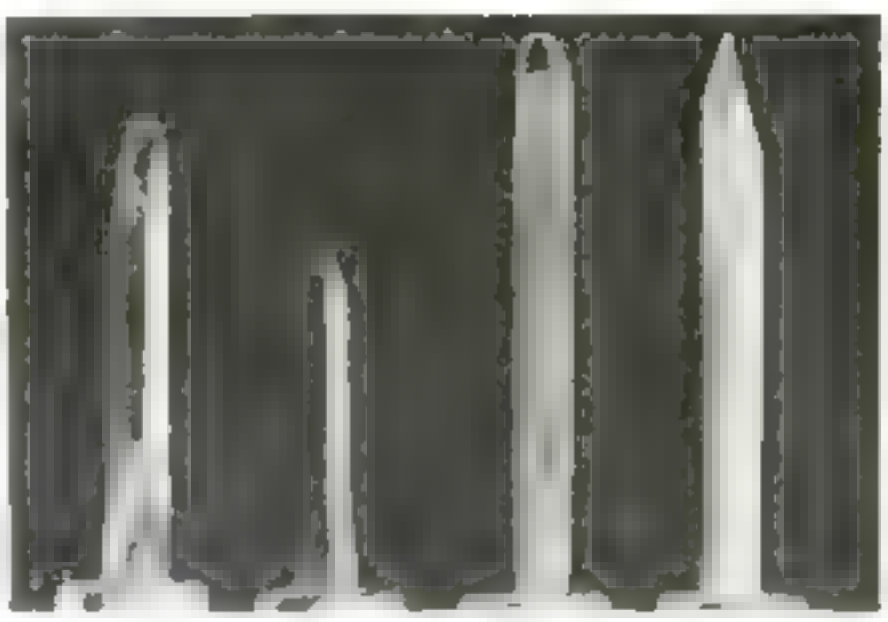
Either paint or stain may be used as a finish. Before painting, fill all exposed countersunk screws in the side panels with a hard-drying filler. If a stain is used, it will be necessary to glue a thin veneer panel over each side panel to cover the screw heads. The drawer fronts should be made wide enough to allow for this.

Model Maker's Turning Tools Are Ground from Small Files

FOUR excellent wood-turning tools, especially suited for model making and other small-scale lathe work, can be ground from two worn-out 6" round files. Break the files in a vise so that the pieces are of about equal length (Fig. 1) and grind them until they are rectangular in shape as shown in Fig. 2. The pointed ends need only be rough-ground (Fig. 3) since they will fit within the handles, but the exposed portions should have all file marks removed. Be sure that the surfaces which will bear on the lathe rest are ground smooth.

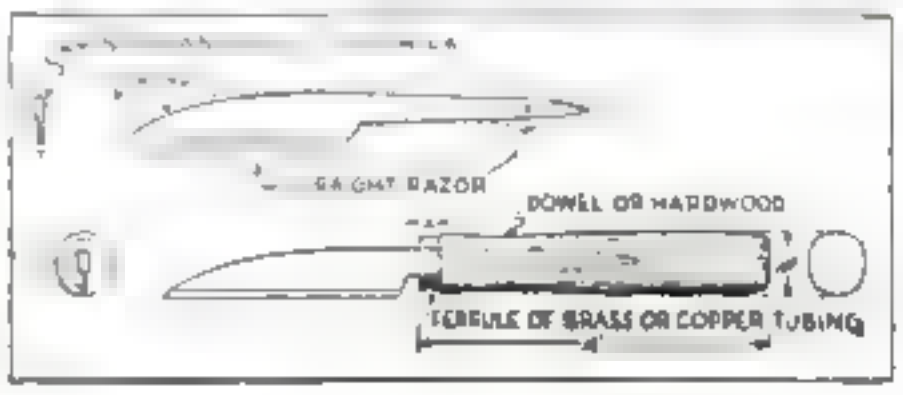
The cutting points should be shaped with particular care to secure the angles shown in Fig. 4; use a grinding jig if one is available. Handles can be made from ⅝" birch or maple dowel. Ferrules are not necessary if the handles are drilled out sufficiently before the tools are forced in. Finish the cutting edges on an oilstone to razor keenness. If you wish to make a set of larger tools, pillar files will need less grinding than larger round files.—C. W. BERTSCH.





Discarded Razor Transformed into Keen Whittling Knife

A WHITTLING knife that will hold an exceptionally keen edge can be made from an old straight razor. Since the original shaving edge is too thin for its new role, it should be ground back about ¼". Do not remove more than is necessary to thicken the edge slightly, because many razors are tempered only part way back from the edge. Take care not to "burn" the steel. Grind the entire blade to the shape shown in the drawing at the right, reducing the thickness at the back if desired. Use hardwood or a piece of ⅝" birch dowel for the handle and attach a ferrule of seamless brass or copper tubing. If such tubing is unavailable, a discarded kitchen fork or spoon will probably yield a ferrule. Restore the knife edge to razor sharpness on an oilstone and make a leather or wooden sheath to fit the blade, as shown in the photograph.—C. W. B.

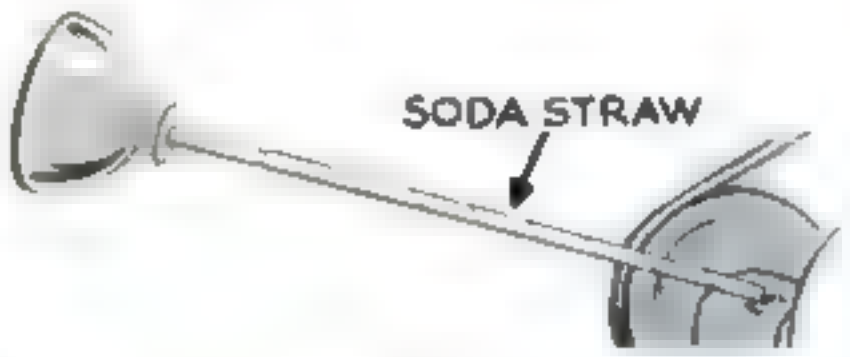


KEEPING THE HOME

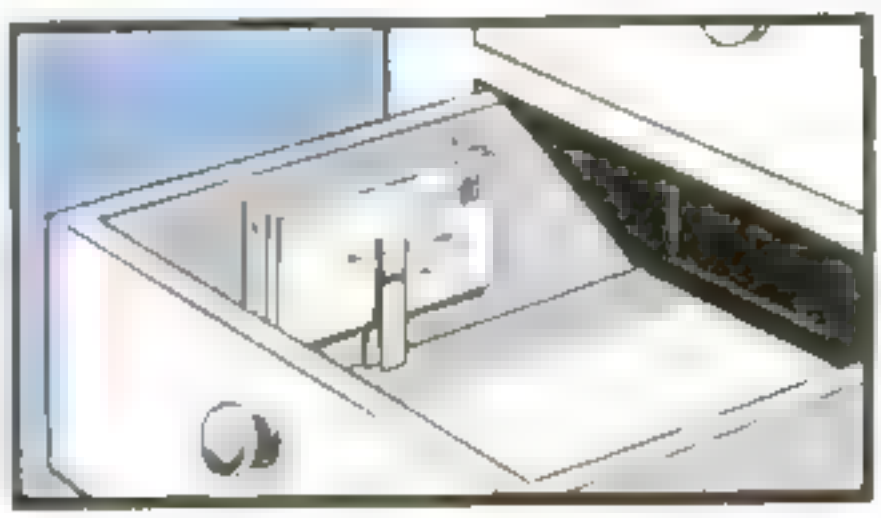
Most people prefer to have a furnace-regulating thermostat installed in a spot where it will not be noticeable and yet will serve efficiently. This often means that insufficient light will fall on the dial for accurate setting. Squinting in a dark corner and guesswork regulation of your heat can be avoided, however, by having a small notch filed in the dial face at the temperature or temperatures most frequently desired so that the exact setting can be made by touch alone. A small triangular notch like the one shown above can be made quickly with a three-cornered file

When loose ration points are received in change, a good precaution against their loss is to place them in an envelope pasted on the inside of the ration-book cover—a convenient, safe receptacle

Furniture casters won't stick to a floor and mar its sheen in very hot weather if a thin coating of floor wax is applied to the wheels. In damp weather a little wax put in the sockets of the casters will keep them rust-free and free-turning

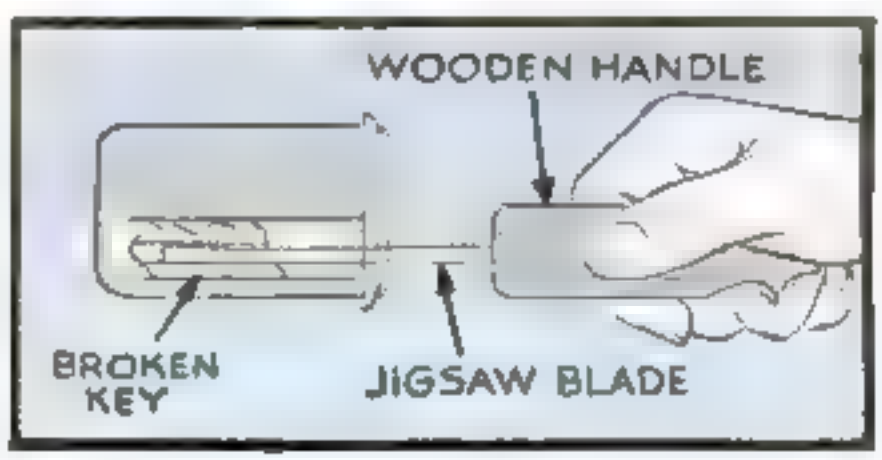


If you need to lubricate machine parts so placed that they are hard to reach, and an oil can with a long spout is not available, try using a soda straw on the end of the spout for an extension



Screw one leg of a spring-type clothespin to the inside of a drawer for keeping letters, bills, and receipts where they can be found when wanted

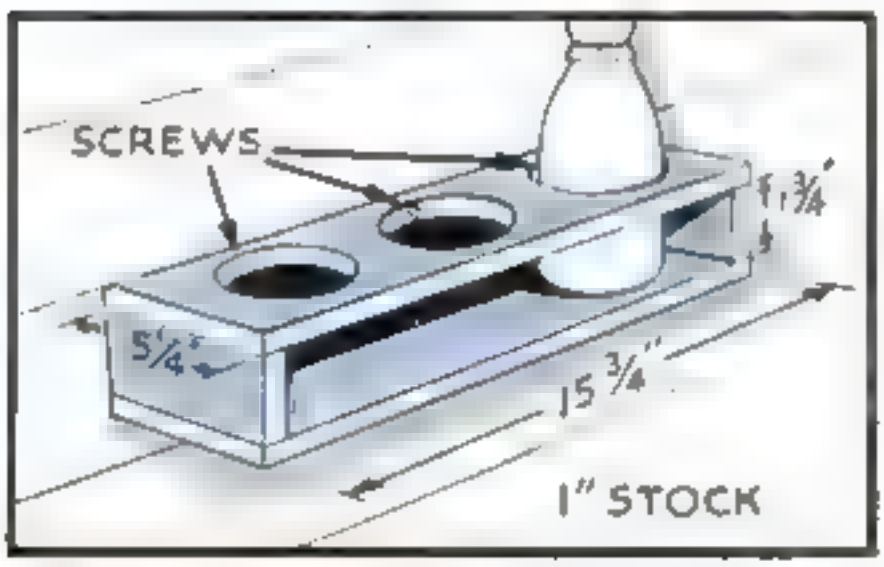
One way to get a broken key out of a lock is with a piece of jigsaw blade. Push the blade into the lock with the teeth pointing outward, twist it so they will be at right angles to the key and pull



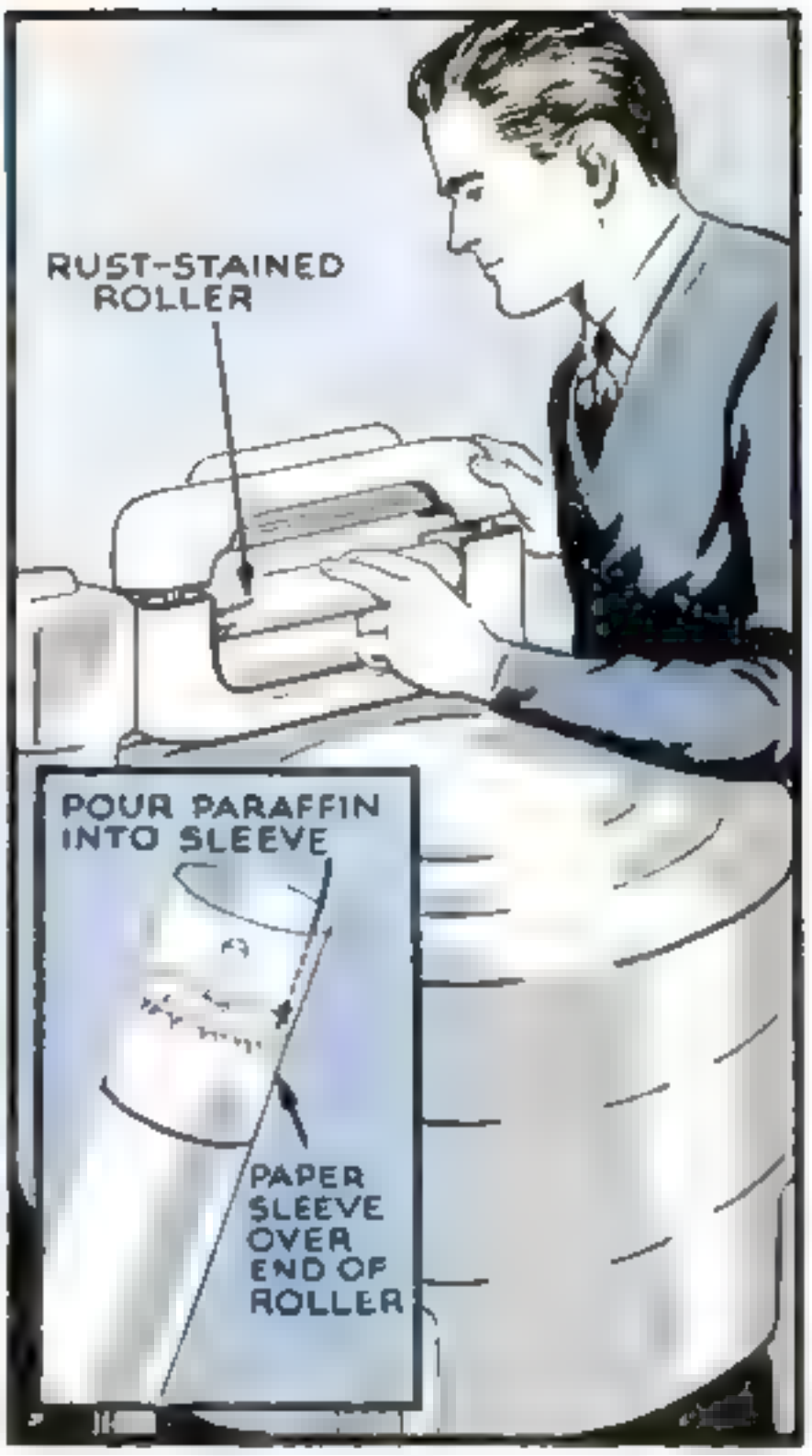
SHIPSHAPE

If members of your family or office staff absent-mindedly pocket a key that should be left for others to use, put the key on a ring that is too big to go into a pocket

In an emergency, a very satisfactory washer can be made for a faucet by removing the metal from the center of a round typewriter eraser. The hole will fit the screw, and the rubber can then be pared to proper size

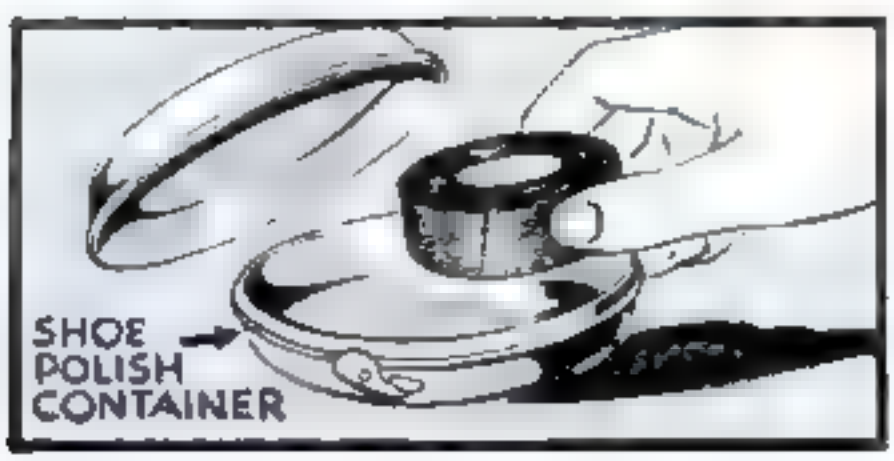


Milk bottles can't be kicked over and broken if they are held in this sturdy wall bracket. Make enough holes for your needs, and slant the back edges of the ends if your house is of clapboard

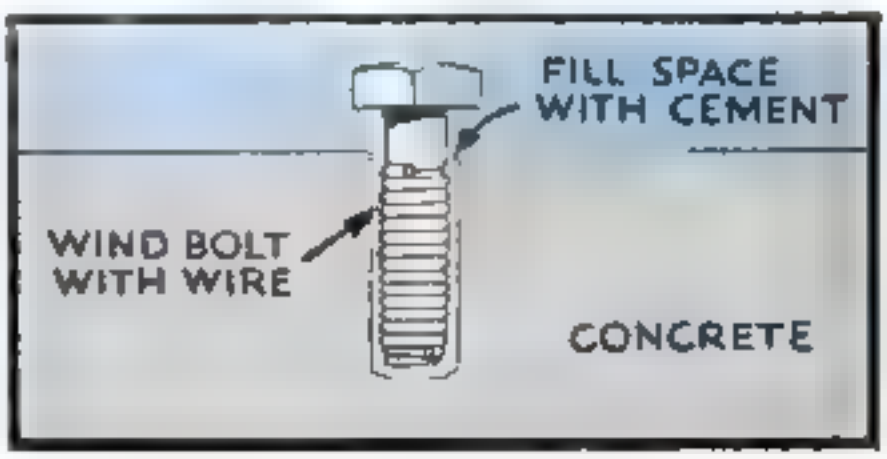


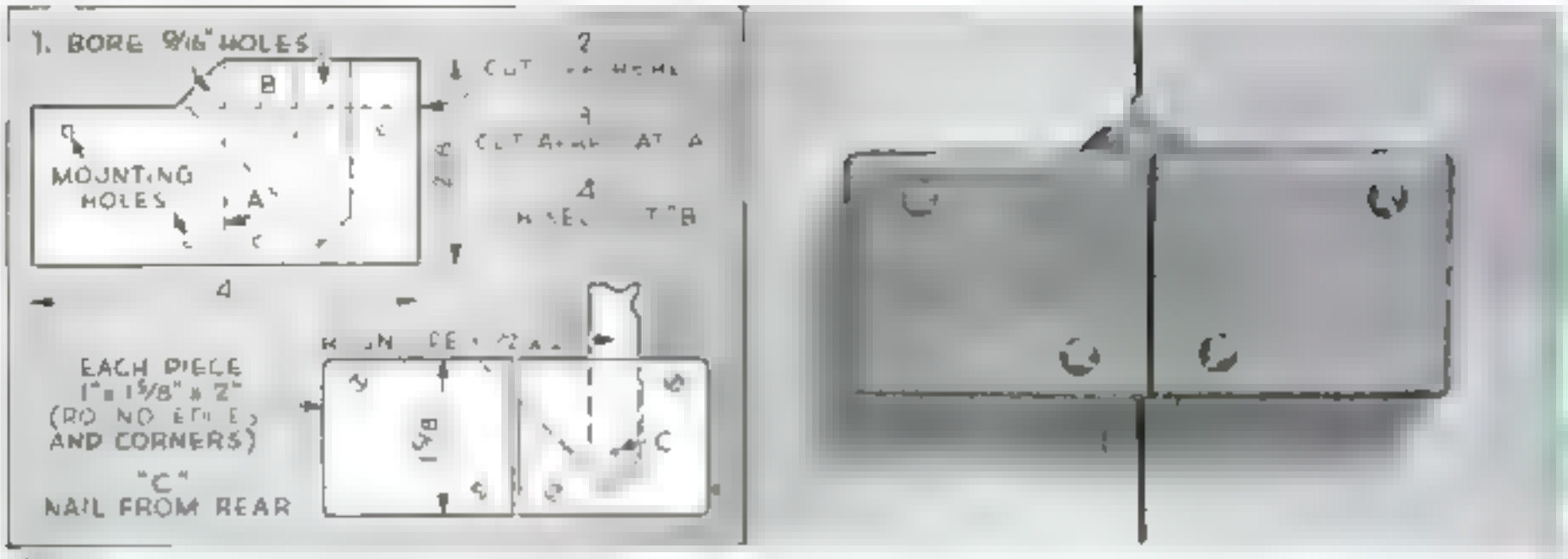
Service-worn clothes wringers can be given many a day of extra life if the rust and discoloration that come in time from their iron roller cores are eliminated. These stains result from water that has seeped into the cores through the frayed and loosened rubber at the ends. A repair may be effected by removing the rollers from the wringer and fastening paper collars around the worn ends. The rollers can then be sealed against water and secured against rust if melted paraffin is poured into the collars. Gears and bearings should be cleaned with gasoline and coated with light grease

Friction tape is likely to dry out and lose most of its adhesiveness when removed from an original wrapper. Use an empty shoe-polish can as a handy, airtight container in which tape will keep fresh



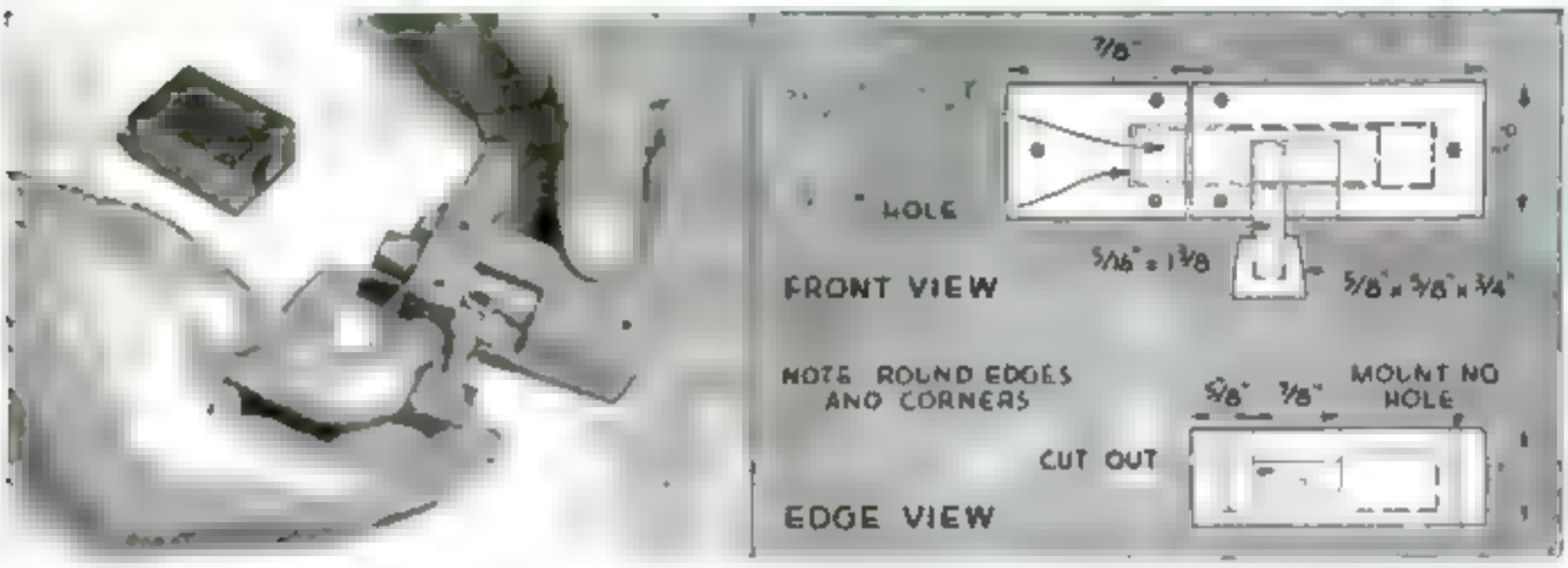
Bolts may be made to hold in concrete by winding the threads with wire, inserting them in drilled holes, and filling the space left with cement. They are withdrawn and reinserted with a wrench





Made entirely of hardwood with the exception of screws, this drop-type latch is designed for use on a home-built cabinet or cupboard. Its pivoted moving part is cut out as shown in the drawing

The sliding bolt shown below, also of wood, is another distinctive latch. The bolt itself is a piece of hardwood dowel, while the remainder of the latch is made up from a block of grained stock. Care should be taken that the grain of the two halves match or form a pleasing contrast



Wooden Hardware Gives Cabinets

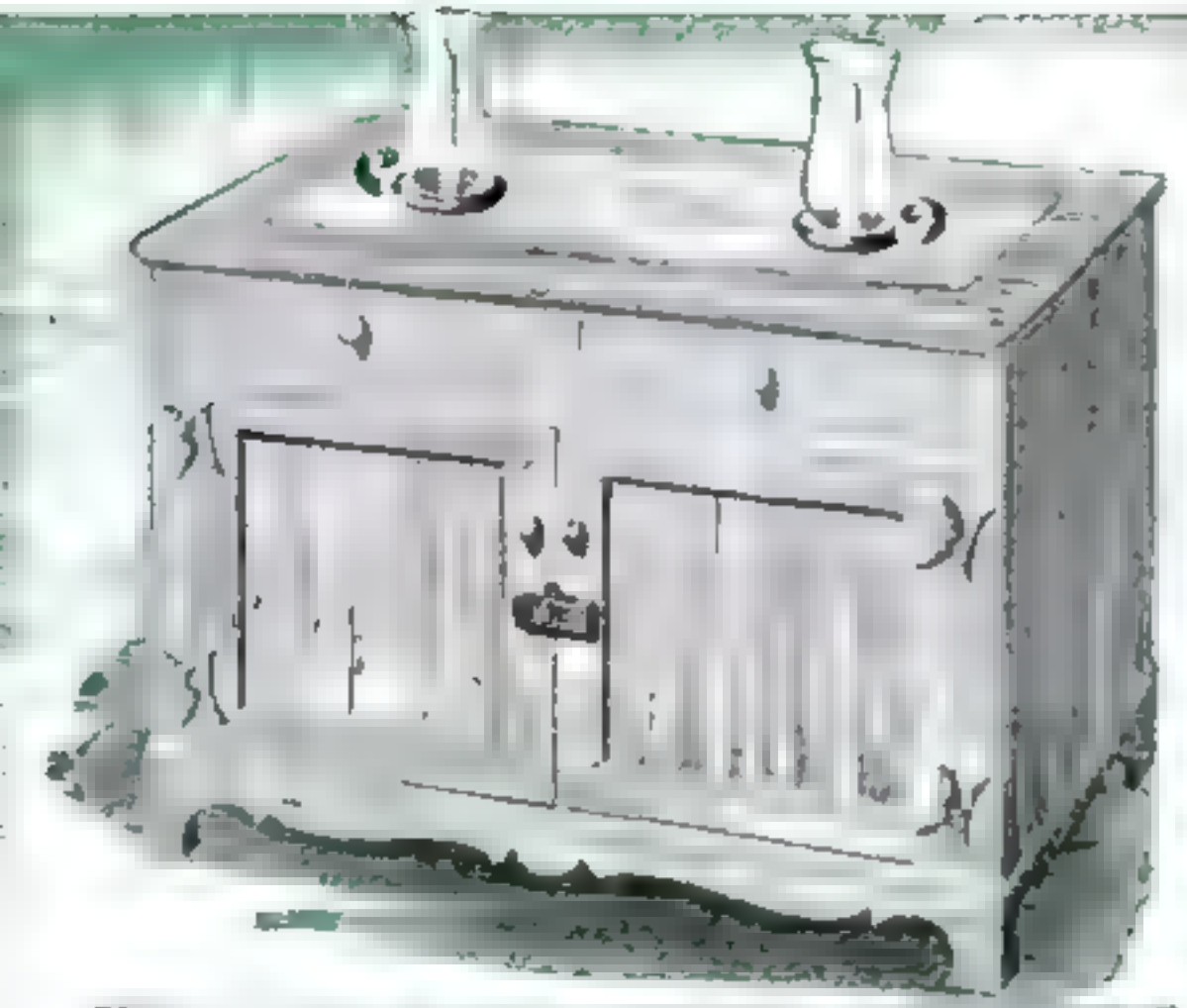
LATCHES AND HINGES MADE FROM NICELY GRAINED STOCK

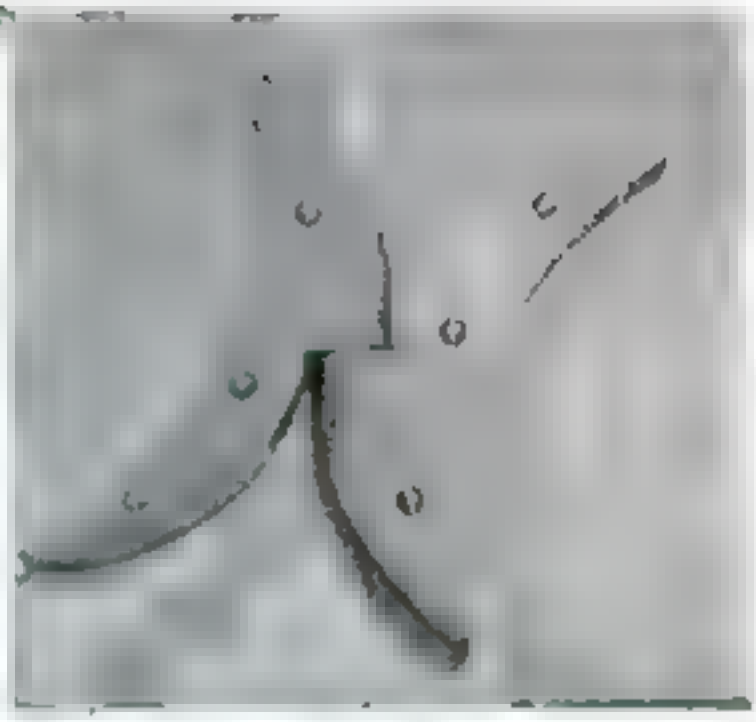
By FRANK WHEELOCK

BEAUTIFUL latches and hinges that blend so closely with the grain of your home-built cabinets and cupboards that they seem to grow out of the wood can be made from small bits of matching hardwood. Others that will have as interesting an effect and add to the distinction of a piece may be turned out by the craftsman from contrasting woods. Many designs are possible, from the simplest lines to highly ornamental carvings, and any will be pleasing so long as the fittings are in keeping with the piece on which they are used.

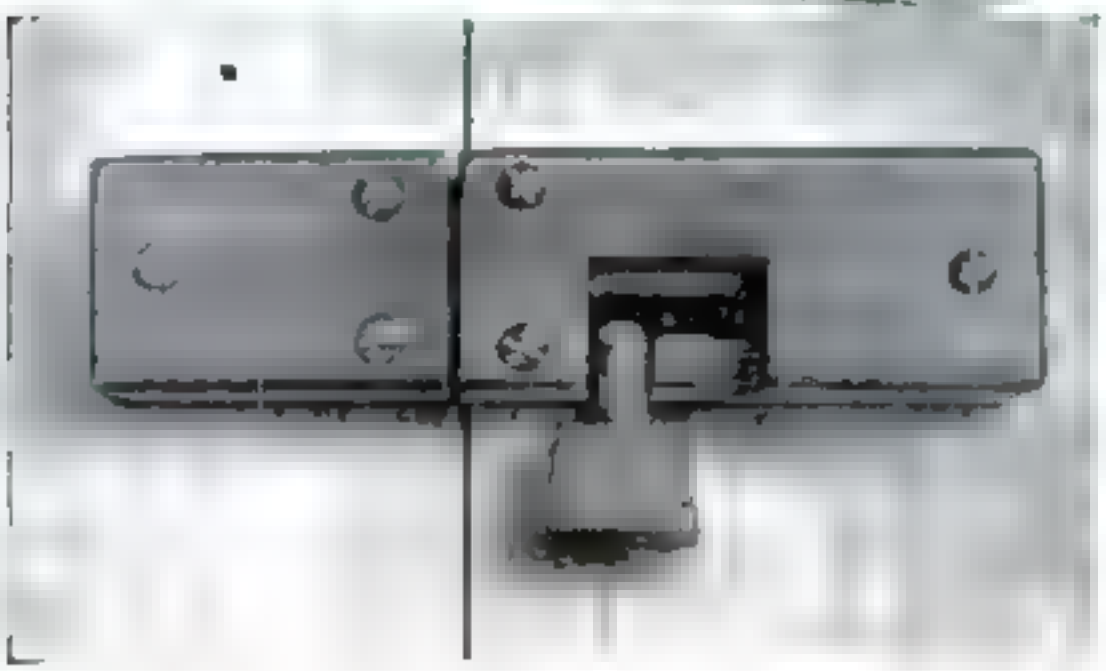
Illustrated are two latches and two hinges for a cabinet door. The dimensions are suitable for many pieces, but the plans are intended primarily to give an idea of what can be done with hardwoods and to form a basis for designs of your own creation.

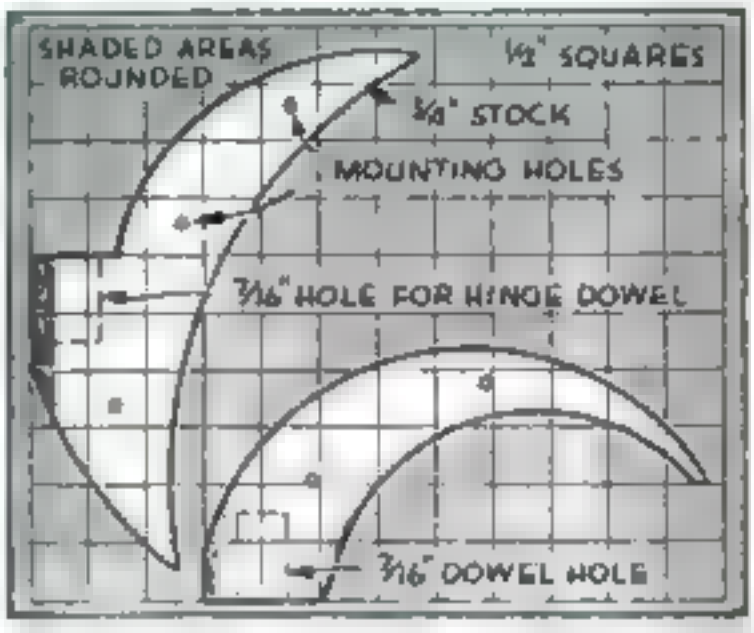
Care should be taken to have a pleasing flow of grain in adjoining parts, or else the grain of two pieces should be turned so that the contrast will be arresting. The two parts of each of the latches shown may be cut from the same piece of stock to obtain a flowing grain, or a small block can be sawed down the center with the grain for



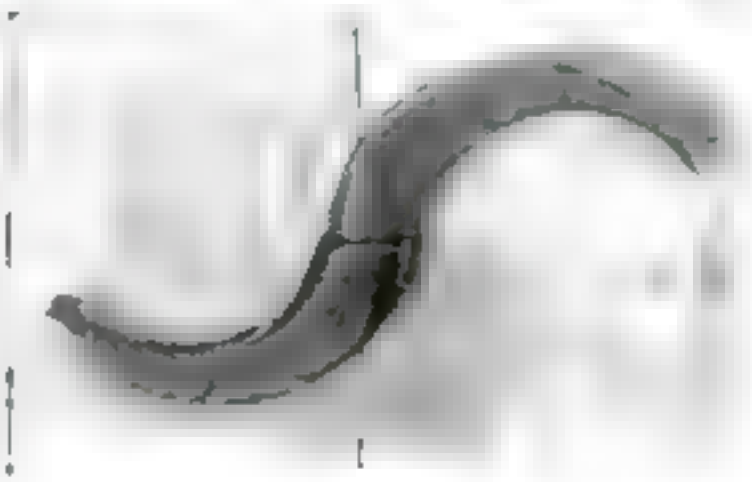


With a length of dowel used as a pin, this wood hinge is strong enough for a cupboard





Another design for a hinge suitable for a door that has greater width than height



New Character

FOR HOME-BUILT PROJECTS

a perfect match. In the latter case, the inside faces are exposed, and the abutting ends are placed to let the grain coincide.

One of the latches illustrated is of the drop type with the moving part pivoted inside one of the halves. This part may be of dowel, shaped at the top as shown in the drawing. It is raised to unlatch the door and dropped into a slot in the corresponding half to hold it shut. The other latch has a sliding bolt cut from a hardwood dowel, while pieces of hardwood dowel also form the pins of the hinges.

Finishing will depend for the most part on the finish of the piece on which the fittings are used and also on the kind of hardwood from which they are made. In many instances, the finish desired will probably be one that will emphasize the wood grain. It should be put on in any case after a trial fit and before final assembly so that no unfinished corners will show in the exposed moving parts. Before the pieces are permanently assembled, all moving parts and contacting surfaces should be waxed and rubbed well. Parts of this kind that do not show, such as the hinge dowels, will need no finish except a thorough waxing. If it should be decided to use paint, don't paint parts between which there is friction.

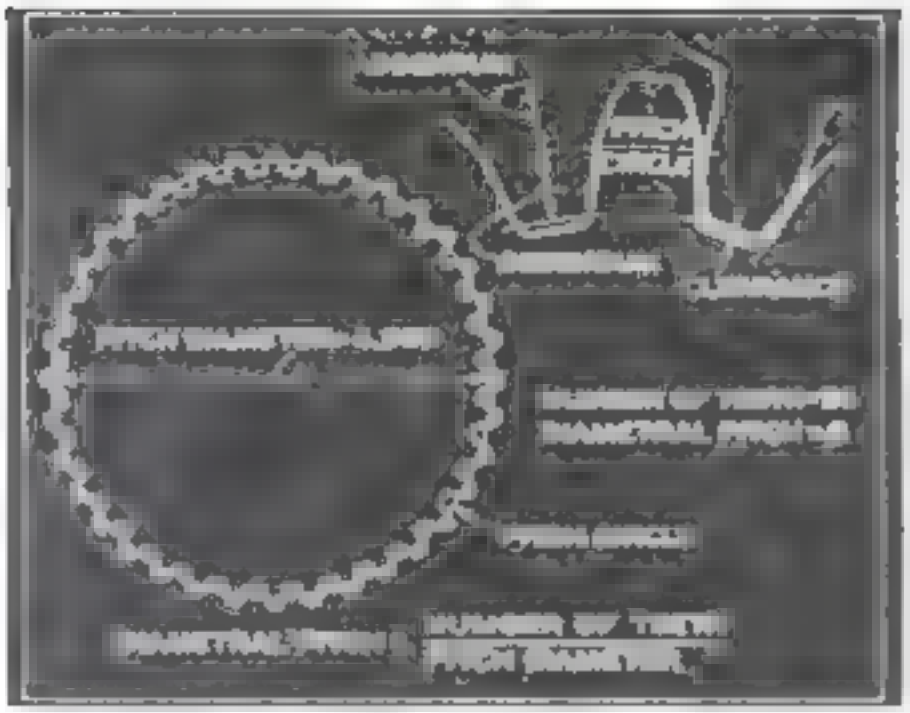
CUTTING GEARS on the MILLING MACHINE

ONE of the oldest and most common methods of cutting gears is on the milling machine, which is still extensively used despite the fact that other machines designed specifically for gear cutting can do the job faster. Gear hobbers, shapers, and planers, for instance, can be set up for mass production of various types of gears, such as spur, helical, bevel, spiral, and herringbone gears.

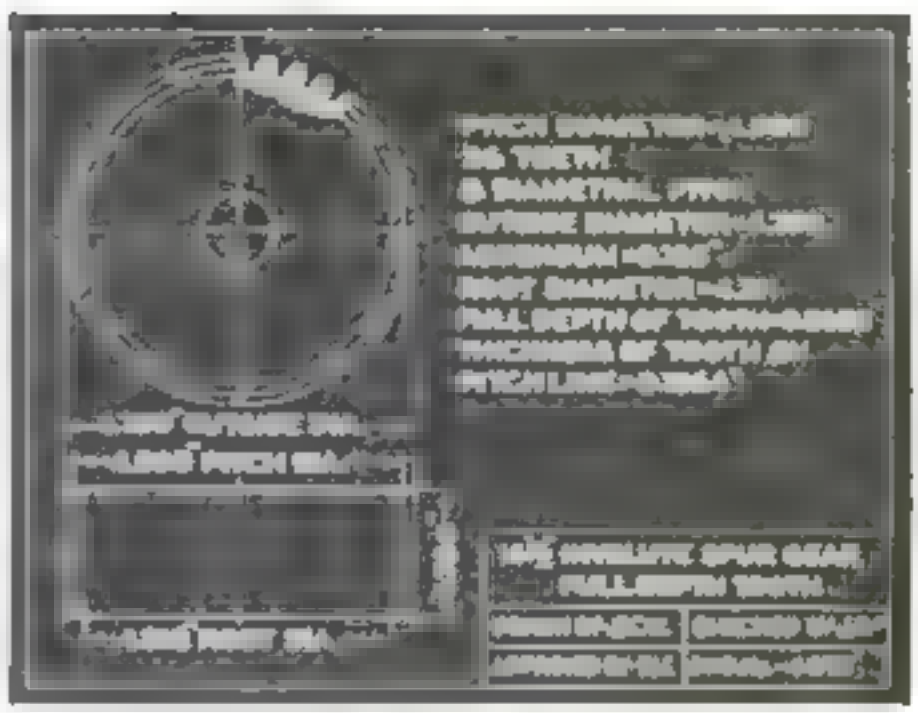
Before using any of these machines, the operator should have a knowledge of the fundamentals and nomenclature of gear-tooth design. Reference to a good handbook will enable him to set the machine to the correct speed and feed for the type of gear to be cut and for the kind of metal of which the gear blank is made. It will also allow him to check on the blueprint to be sure that none of the dimensions are contradictory. In addition, he should check the cutter to be used to make the gear with both the specifications given in the blueprint and the data in the handbook.

Actual setting up of the milling machine for gear cutting and its operation, along with important points in gear design, have been made the subject of one of the series of motion pictures used by the U. S. Office of Education for training machine-tool operators. Frames from this film, which is distributed for the Government by Castle Films, appear on the succeeding pages.

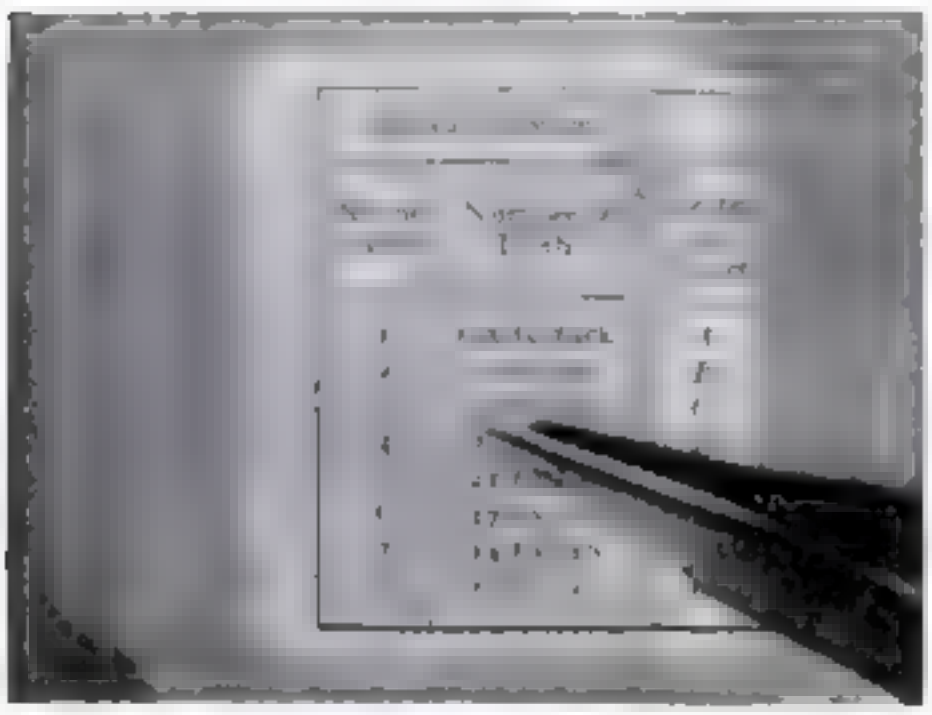
In setting up the milling machine, be sure to place the outer-arbor support as close to the cutter as possible without danger of the gear blank striking the cutter. If the distance between this support and the machine column is too great, the cutter arbor will spring upward under pressure of the cut and result in teeth of uneven depth. For the same reason, a table jack is used to support the gear blank for the fairly heavy roughing cuts. Just how important it is to keep the cutter arbor and the gear-blank mandrel steady can easily be seen when one considers that the clearance of an 8-pitch gear of 36 teeth is only .0195".



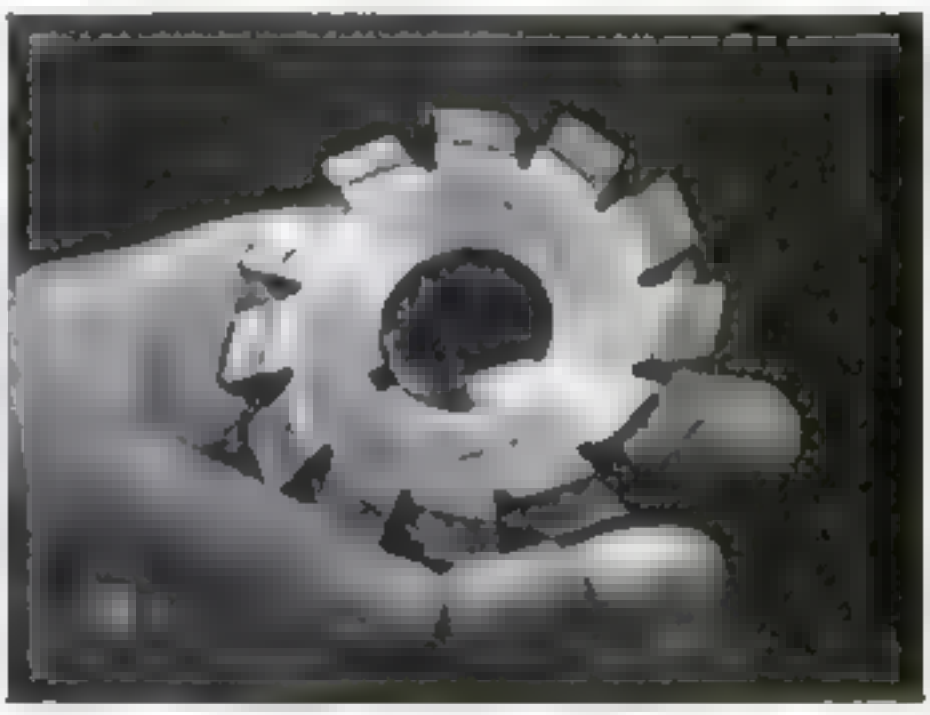
1 On gears, the pitch circle cuts the working center of the teeth, addendum and dedendum are equal, and clearance is added to give full depth of tooth. Diametral pitch is used in calculations



2 Here is the job. Cut 36 teeth in a gear blank machined to dimensions in the blueprint. The center hole is drilled and reamed so the face will run true when the gear is mounted on the mandrel

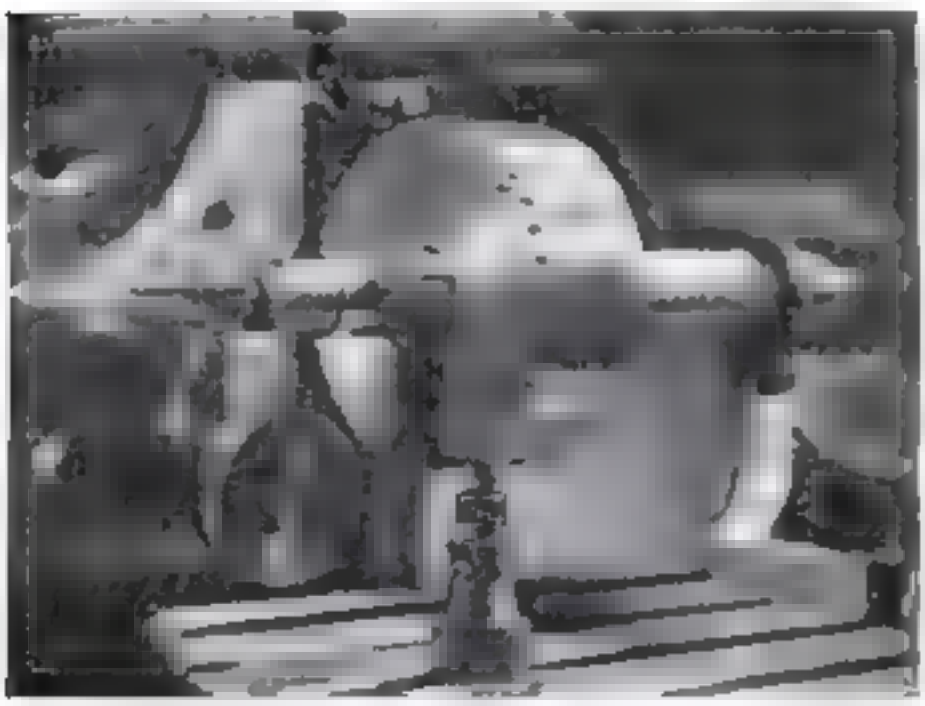


3 Since the shape of the teeth is to be involute, refer to the involute-system table of cutters in a handbook. A No. 3 cutter will provide this shape when the number of teeth is from 35 to 54

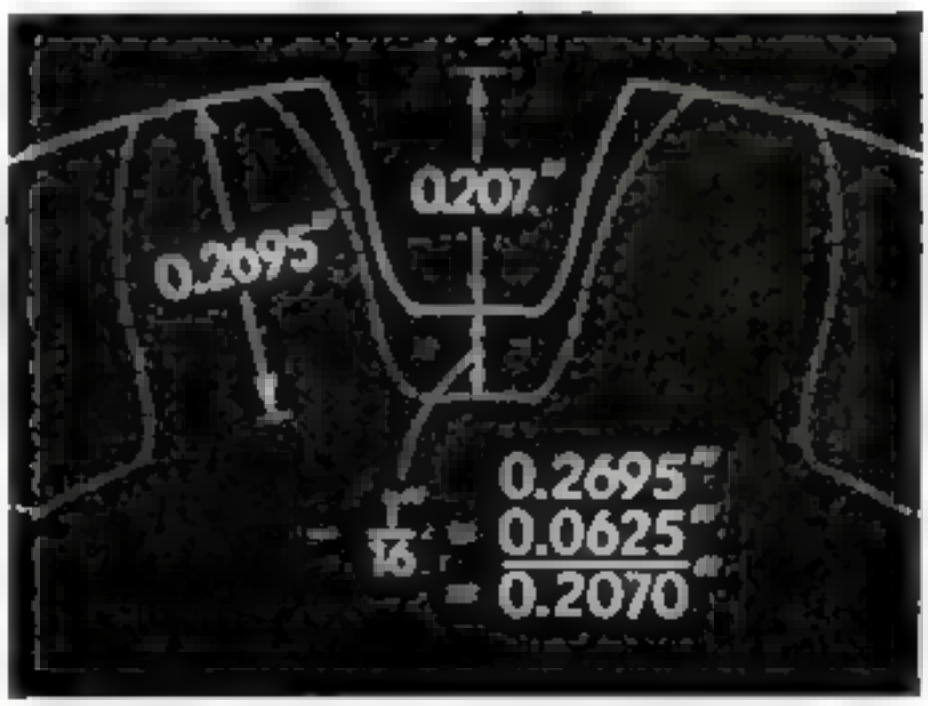


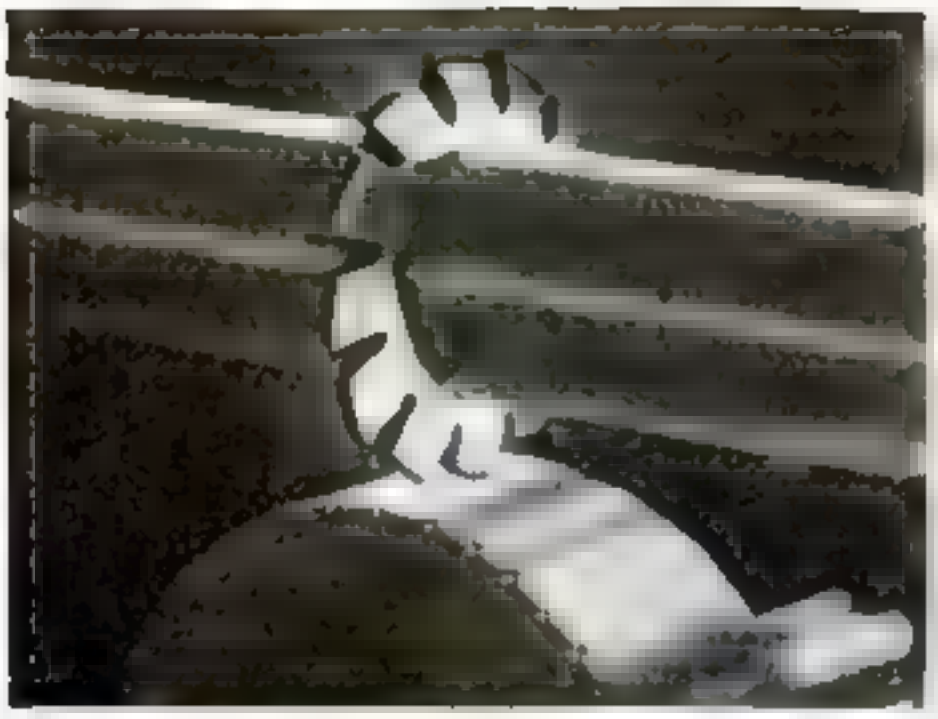
4 Specifications are stamped on the cutter. Here the diametral pitch (8), the number of teeth (35-54), and the full depth of tooth (D+f=.270") meet the requirements of the blueprint for the job

5 The blank below has been set up and notched for 36 teeth following a trial setting of the dividing head (see P.S.M., Oct., p. HW 481). A table jack keeps the mandrel steady during cutting



6 One roughing cut and a finishing cut of 1/16" will be sufficient for teeth of this size. To determine the depth of the roughing cut, subtract 1/16" from the full depth of tooth *(continued)*

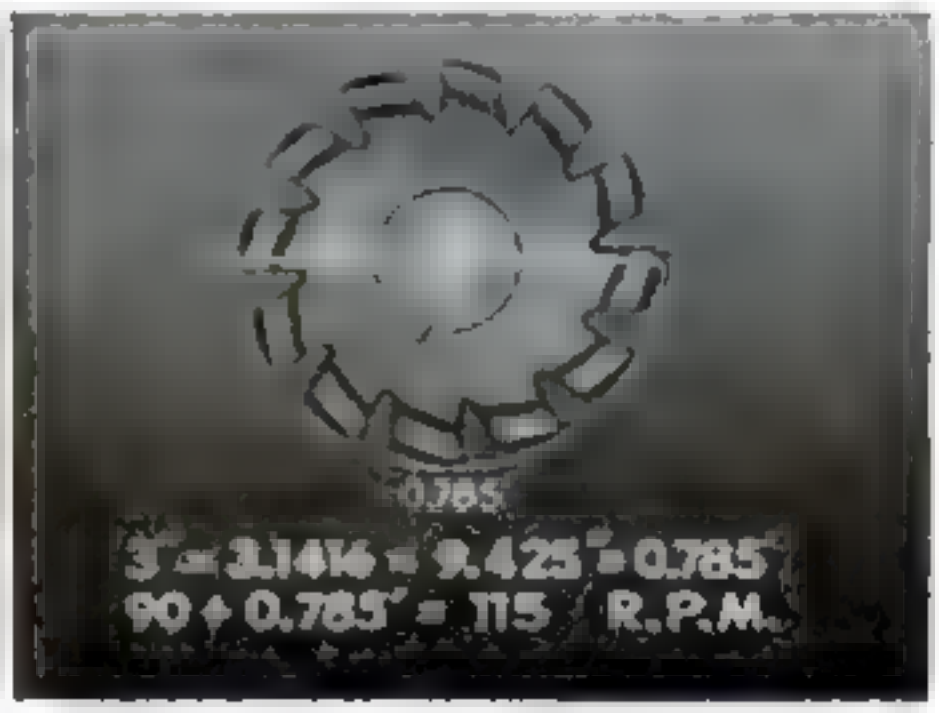




7 As the first step in setting the machine for the depth of the roughing cut, the cutter is slowly rotated while the table is raised by hand until the cutter barely scrapes the gear blank

8 At this point, the index dial on the handwheel that moves the table vertically must be set at zero. Each division on the dial represents .001" and a complete revolution raises the table .100"

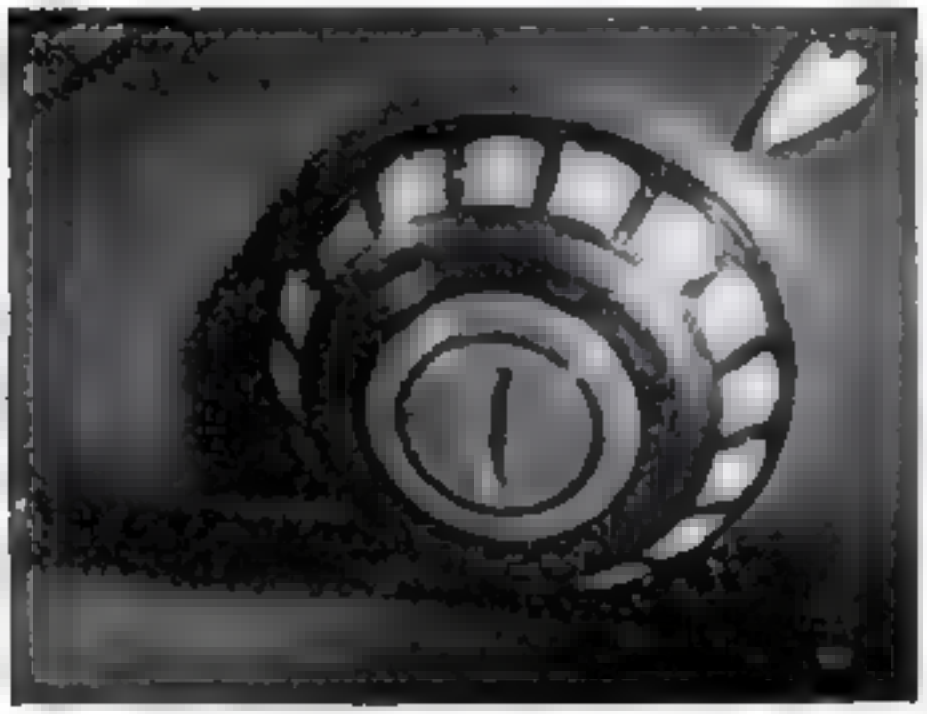
9 Run the table forward so the gear blank will clear the cutter; then raise it .207" for the roughing cut. This is accomplished by two full revolutions plus seven divisions on the index dial



10 Cutter speed is next calculated. Since the gear is cold-rolled steel, a speed of 90' per minute is required at the cutter teeth. Dividing this by the cutter circumference gives 115 r.p.m.

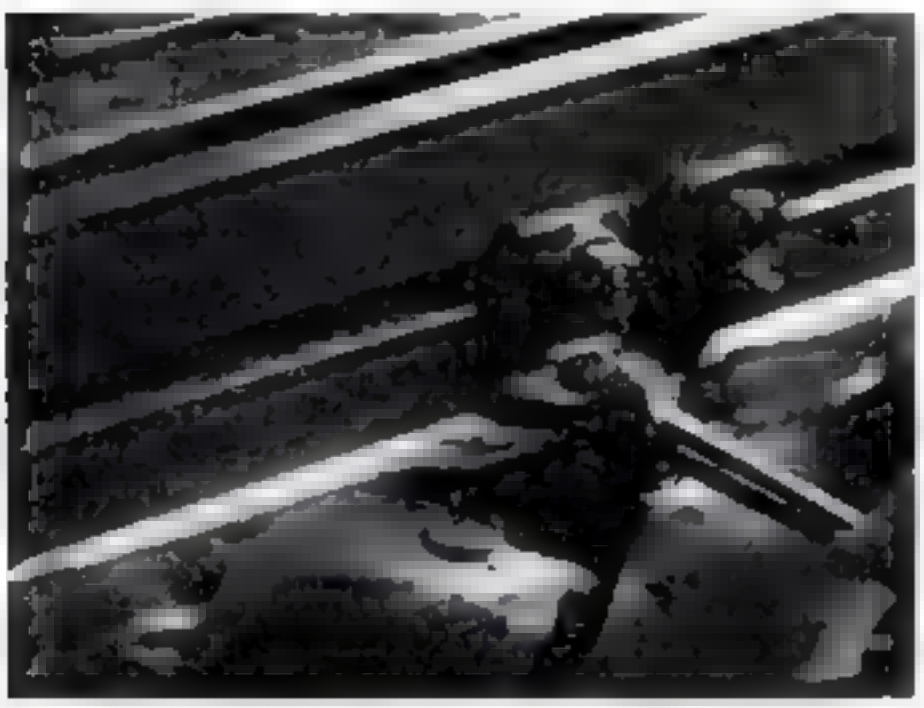
11 On most milling machines, the cutter or arbor speed can be set by a speed selector. Below, the speed dial is set at 116 r.p.m., the nearest speed of this machine to that required for the job

12 Feed, the speed of the table movement, is now determined. The 12 teeth of the cutter will remove 12 chips .002" thick in one revolution, so the feed should be 116 r.p.m. multiplied by .024"



13 This gives a feed of approximately 2¾" per minute, at which point the feed-selector dial is set. It represents the distance in inches per minute the gear blank will be fed into the cutter

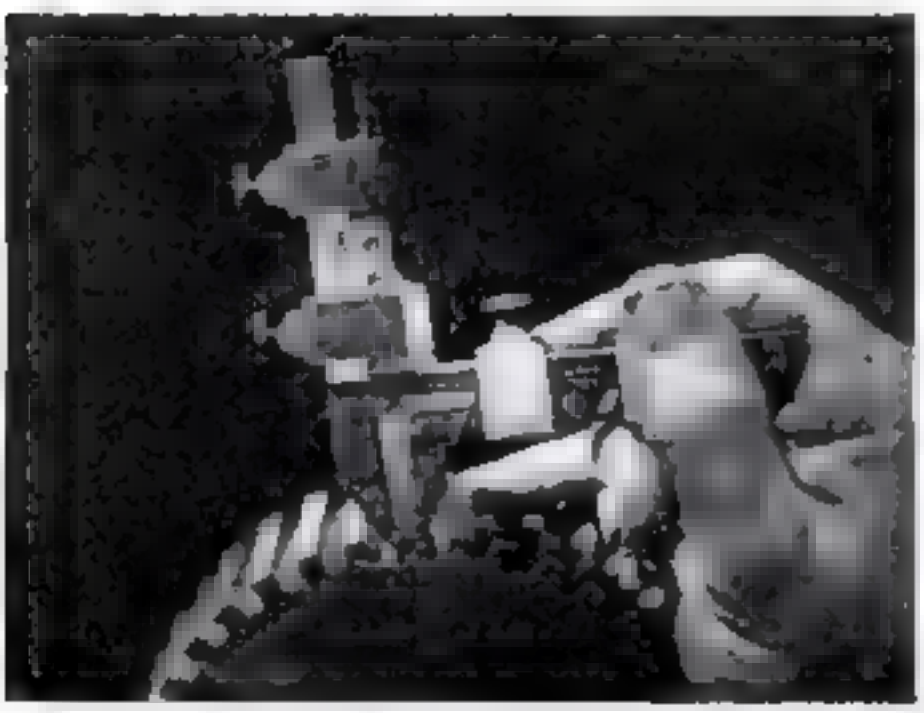
14 With the depth of cut, cutter speed, and feed set, take the first roughing cut, being sure to use an ample supply of cutting fluid; then stop the machine when the cutter just clears the blank



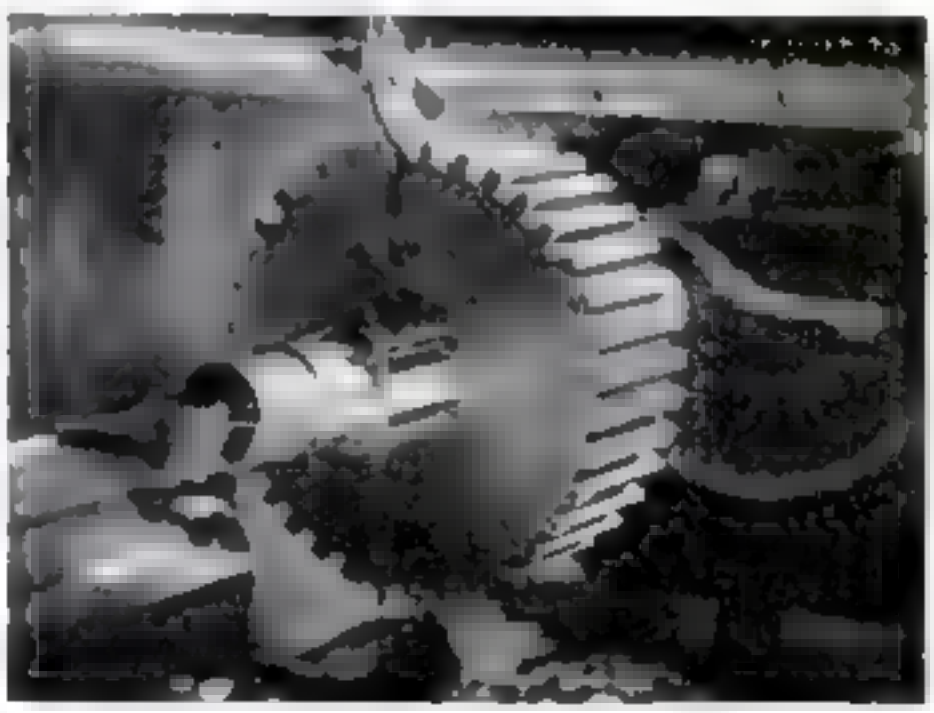
15 Set the table stop dogs to limit its travel at the point where the cutter clears the work. This keeps the cutter from traveling far enough to damage the dividing head and also speeds the job

16 Stop the table at the end of each reverse stroke and index the blank for the next tooth according to the dividing-head setup. Due to backlash, indexing must be continuous in one direction

17 When all 36 teeth are rough-cut, raise the table 1/16" and make a finish cut; then index one space to finish the second face. Check width at the pitch line with gear-tooth vernier calipers

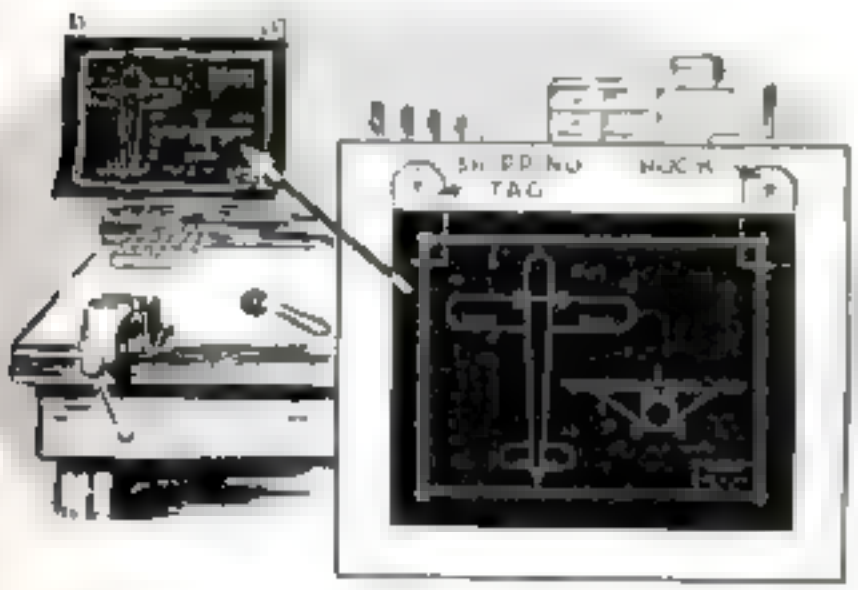


18 Cutting depth is adjusted, if necessary, to correct the pitch-line width. Indexing then proceeds forward for the rest of the gear. Cuts are light, and the table jack is no longer needed

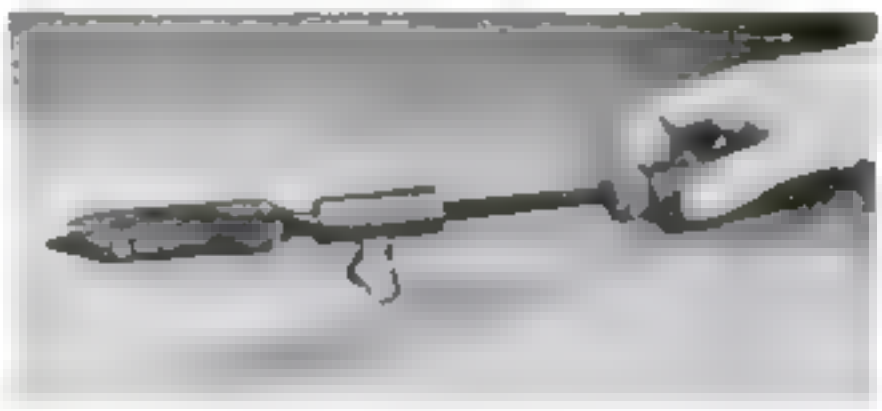


New SHOP IDEAS

BLUEPRINTS remain cleaner and last longer if they are kept off workbenches and left uncreased. One foreman lengthens the life of shop drawings by stapling two shipping tags behind the top edge of each as shown below. The blueprints can then be hung on two screw hooks over the workbench or machine where they are needed. A large number can be stored on two long curtain-rod hooks. If staples are not available, the tags can be attached with glue.—RONALD EYRICH.



AIR PRESSURE speeds air power to smash the Axis. In the Fisher Body Division of General Motors, an ingenious trick suggested by Russell Dudley, an employee, has cut by 17 percent the time required to install electric wires in horizontal stabilizers. This was formerly done by first pushing through piano wire, which frequently caught at sharp bends in the conduit. Dudley's method is to tie the electric wire to a piece of string, blow the latter through with compressed air as shown below, and then pull the wire through.



IN SOLDERING, a hot iron put down hastily or carelessly may char the bench or table top. If a spring-type paper clip is previously put on the tool just behind the head, such damage will be avoided. Spread the grips of the clamp slightly to afford a broader support.—W. SWALLOW.

Courtesy *Grits and Grinds*, a Norton Company publication.

WORN PIPE WRENCHES can be restored to service by regrinding the teeth on the jaws. This can be done by hand on any bench grinder equipped with a 100 or 120-grit, medium-grade wheel running at 5,000 surface feet per minute. The wheel face should have one sharp and one rounded corner, the sharp one to grind to the root of the teeth and the rounded one to provide clearance when teeth are being ground close to the shank of the jaw. It is usually the teeth on the movable jaw that require sharpening. The angle between teeth is generally 100 deg., and this should be preserved as closely as possible in regrinding. A dull wrench can usually be reconditioned in this way in a few minutes. Teeth can be resharpened several times if care is used, the depth of hardness and the amount of metal removed on each occasion being the only limitations on the life of a wrench so reconditioned. A simple file test will show whether the teeth are still hard; a triangular testing file should just bite enough not to slide over the teeth.

Shop Marking Gauge Has Replaceable Scriber

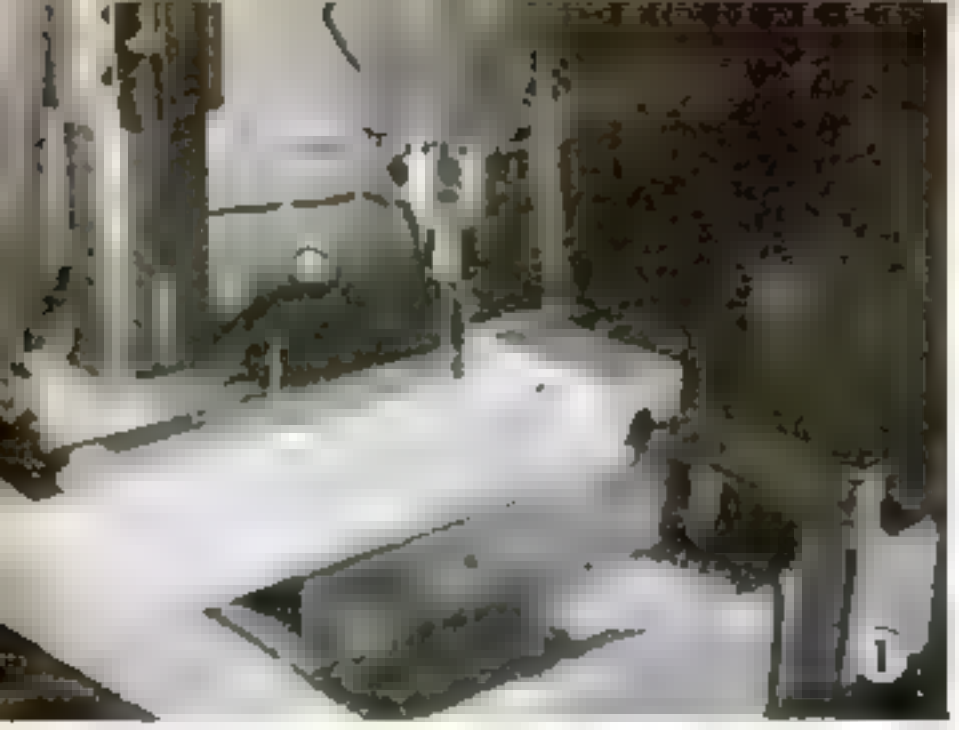
By C. W. WOODSON

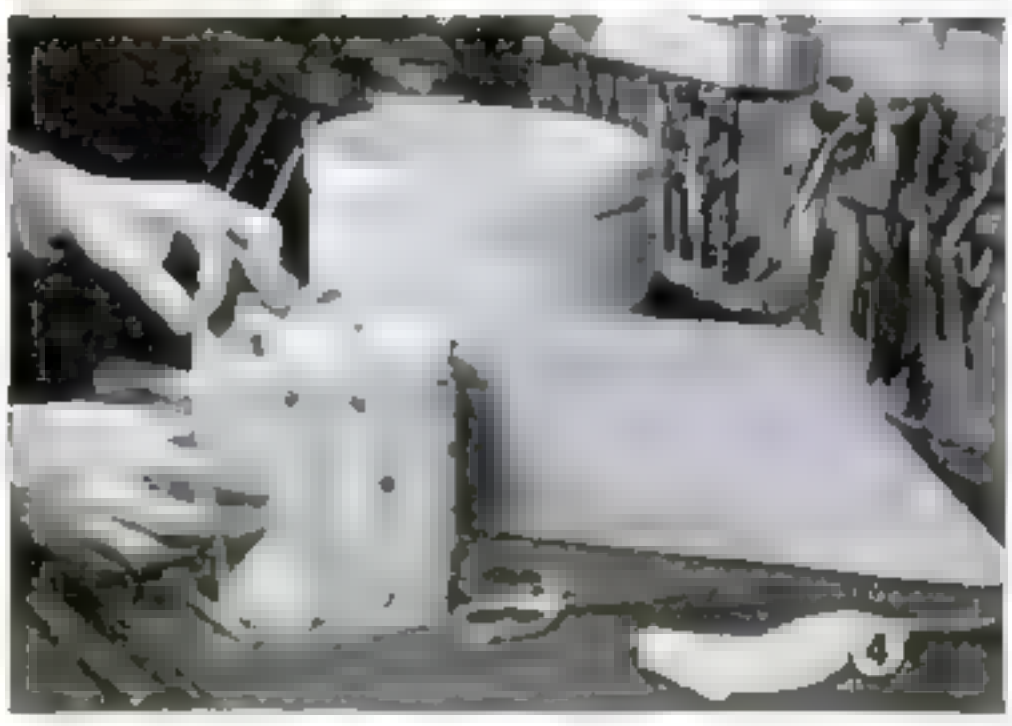
FITTED with a phonograph needle as a scriber, the gauge shown above will be found useful in making extremely accurate layouts on metal. Continued fineness of lines is assured since the needle can be changed when it becomes dull. The gauge is particularly suited to shops where aluminum sheet or steel plate is worked, but it will be a handy accessory also for many operations in home workshops.

Chucked as in Fig. 1, a short piece of 2½" shafting was turned to make the base. A center hole was then drilled in the end for tailstock support, and the handgrip was knurled as shown in Fig. 2. During this operation, the tool should be kept flooded with oil, and the knurls should be sunk deeply enough into the work to make a perfect diamond pattern.

With the knurling complete, and the work still in the chuck, a hole was drilled through and reamed to the diameter of the spindle (Fig. 3). Then a hole for a thumbscrew was drilled and tapped 10-32 in the side of the gauge, and the thumbscrew was turned and threaded on the end of a ⅜" rod. The head was knurled, and the complete screw was finally cut off. An 8" length of drill rod forming the spindle was faced square at each end and drilled to receive the scribing point and a setscrew to hold it securely.

Detailed specifications for the metal-marking gauge





SMALL ELECTRIC

Resistance Furnace

HAS MANY SHOP USES

By Walter E. Burton

TEMPERING small tools, bluing metal parts, melting lead, and baking enameled pieces are just a few of the uses to which this efficient little furnace can be put in the small shop or laboratory.

A resistance coil of the kind used in electric heaters and toasters forms the heating element. Such an element can be purchased at an electrical supply house or salvaged from a discarded appliance. The furnace shown, designed to reach temperatures up to 1,000 deg. F., has one that draws 520 watts. Higher temperatures can be obtained by using a 1,000-watt element, or by making the heating chamber smaller.

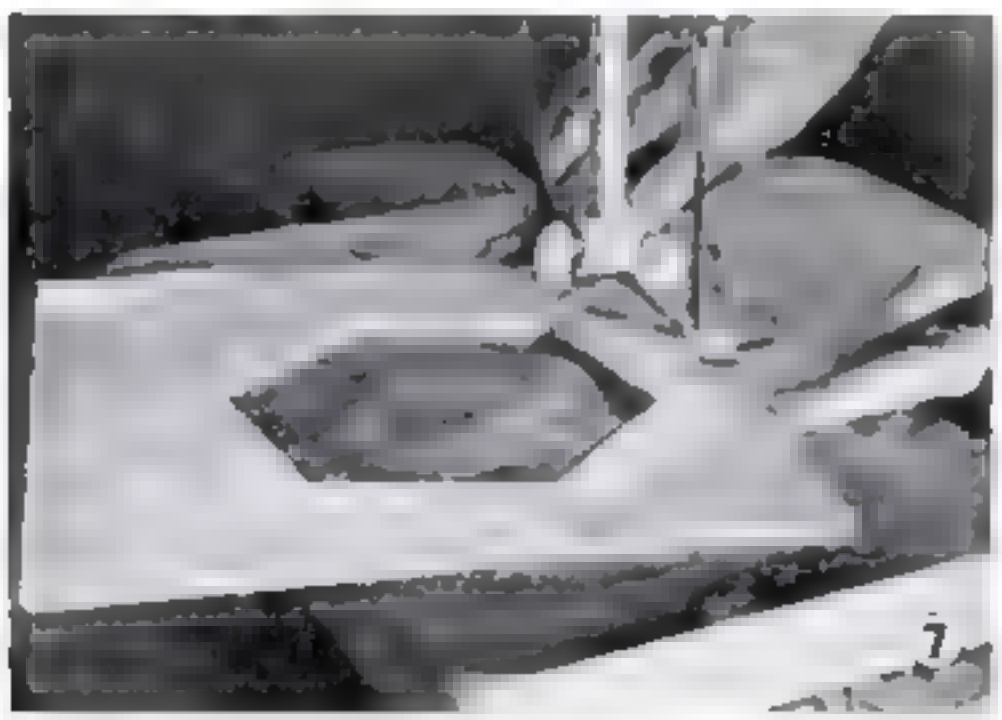
Two concrete-asbestos shingles ⅛" by 9½" by 24", either smooth or textured, are needed for the furnace chamber. With a hacksaw, on a jigsaw, or by scoring the material with an awl and breaking it over an edge, cut six rectangles measuring 1¾" by 6". Cut also a hexagonal bottom measuring 1¾" on each side.

A jig such as that shown in Fig. 1 will speed the work of drilling a 1/16" hole ½" from the end and ⅛" from the edge at each corner of these pieces. Center a similar hole ½" from one end of each to receive an S-shaped hook for holding the resistance wire. If you intend to use a crucible in the furnace, particularly a metal one, drill a hole in the center of each piece to take a 6-32 screw. Left long enough to project about ⅜" and secured with nuts, these screws will prevent the crucible from touching the element.

Link the rectangles together with small wire loops as shown in Fig. 2, with all the centered holes on the same side.

The coil hooks can be made of iron, copper, or nichrome wire. Insert the lower ones in the holes drilled for them and the upper ones through the links holding the pieces together. Drill a hole near the upper corner of each end rectangle to secure the two ends of the resistance wire. Measure the distance the wire will have to stretch, pull it out to slightly less than this length, and mount it as in Fig 3.

With the element in position, fasten the two end rectangles together and insert the hexagonal bottom, securing this with some



black furnace cement. Wrap a strip of asbestos paper around the outside of the unit as shown in Fig. 4. Tie this with wire.

Expanded mica, rock wool, or similar fireproof insulation material is used to line the furnace body, which may be a 2-gal. crockery jar or a metal can or bucket 8½" in diameter and as deep. Pour enough of the insulating material over the bottom to bring the heating chamber even with the top of the housing as in Fig. 5; then pour more insulation around the sides, tamping it firmly.

The connecting wires should be of the asbestos-covered type, but may be bare for the last 2" inside the crock if well separated Secure them outside with a grooved wood or fiber block and a wire as shown in Fig. 6.

From the same asbestos shingle material, cut a disk to fit the crock with a hexagonal opening to accommodate the top of the heating chamber, as in Figs. 7 and 8. Add insulating material to within ⅛" of the top and fit this cover in place. A 7" disk of the same material fitted with a metal ring or knob serves as a lid for the furnace.

Work should rest on a platform of fire clay, firebrick, or metal about halfway between top and bottom. Some pieces may be suspended on wires from a rod laid across the top. For accurate temperature control a pyrometer should be used. The finished furnace ready for use is shown at the right.

Photo courtesy of Westinghouse

How the Vacuum-Tube Grid

By JOHN W. CAMPBELL, JR.

USEFUL though the diode is in its various applications, it was not until Lee De Forest in 1907 inserted that simple third element—the grid—between the cathode and plate that the vacuum tube came into its heritage. That controlling grid has made it the indispensable tool not only of electronics, but also of physics, chemistry, medicine, metallurgy, and astronomy. It has rendered the electron the servant of industry instead of a plaything of the laboratory.

A diode passes current whenever the plate is positive with respect to its electron-emitting cathode. That plate-circuit current can be increased or decreased in just two ways: by controlling the emission of electrons (which in a thermionic-cathode tube can be done by varying the cathode temperature) or by altering the positive potential on the plate. Either method requires comparatively large current changes, such as we can bring about by the use of variable resistors, as in Fig. 1 in the drawings on page HW 558.

Suppose, however, that we inserted a miniature Venetian blind between the cathode and the plate, along with a microscopic motor that could open or close its slats. If the slats were closed, electrons from the cathode would be unable to reach the plate; no current would pass. With the blind open, only a few electrons would strike the slats; the majority would pass through, and a plate current would flow.

If we could build so tiny a Venetian blind, and a small enough motor to control it, we would be able to control a fairly powerful plate current by means of a small current —the current needed to energize the motor. But although mechanically possible, the method is complicated and impracticable. Instead, the triode tube makes use of an electrostatic equivalent of our Venetian blind—a grid. Its slats are not metal, but electric fields, and they can open and shut smoothly 10,000,000,000 times a second.

The grid is simply a lattice of fine wires

Electrical nerve centers of glass and metal speed the messages of modern warfare. These high-power transmitting tubes, destined for the U. S. Navy, will help to maintain ship-to-shore communication

between cathode and plate, or, in some tubes, an open helix of wire surrounding the cathode. If connected to the cathode and therefore at the same potential, a grid presents to electrons emanating from the cathode the same appearance of an open network as it does to the eye (Fig. 2 on page HW 558) and the full plate current passes.

Suppose, however, that the grid is made more negative than the cathode by applying to it an additional negative potential of, say, -1 volt. Nothing will appear changed to us, but electrons, "seeing" electrically, will behold something like the grid shown in Fig. 3. The wires have been electrically "inflated" to many times their original size, and the space between them through which electrons can pass has been diminished. The electrons on the grid constituting that charge of –1 volt will repel some electrons that would have passed before. Furthermore, a grid negative in respect to the cathode tends to block the strong positive attraction of the plate. Fewer electrons reach the plate, and the plate current is smaller.

If we increase the negative potential on the grid to –2 volts by crowding additional

Controls Electrons

electrons on it, the wires will be inflated still more, as in Fig. 4, and even fewer electrons will reach the plate. Finally, if a sufficient negative potential is applied, the electrostatic fields around the grid wires will completely overlap as in Fig. 5—the "slats" of our electrostatic Venetian blind will be closed—and no current whatever will flow across the tube.

When grid wires are closely spaced, even a charge of a few volts will block the plate current completely. If they are widely spaced, a higher negative potential is necessary.

In the triode, or three-element tube, we thus have a method of controlling the plate current that the diode did not afford. The vastly important advantage of this grid control is that a mere charge—a potential, not a current—will affect the plate circuit. The triode is an ultrasensitive relay, in which an infinitesimal current can control another current powerful enough to fill an auditorium with sound through a loudspeaker, open doors, control heavy machinery, or do other useful work.

A potential as small as .001 volt is detectable in a standard amplifier. A vacuum tube such as the 6F5-G will react to a current of one one-hundred-billionth amp. In a special two-tube circuit, a current of less than one ten-billionth amp. controls a current of 1 amp., which in turn can control 1,000 amp. or more. Special tubes can detect a current consisting of only 30 electrons per second—a flow so infinitesimal as to be meaningless when expressed in amperes.

The reason such sensitivity is possible is that individual electrons fed onto the grid have a cumulative effect. As the grid cannot emit electrons, they cannot escape. Because the grid is already negative, electrons emitted by the cathode are repelled by it and cannot affect it. As the tube is evacuated, there are no gas ions to be attracted by the grid and discharge it. In a theoretically perfect tube, having a perfect vacuum and a fully insulated grid, a current of one electron per hour on the grid would eventually mount to a potential that would block the plate current completely.

But the triode has, in addition to its amazing sensitivity to minute electrical potentials, another important characteristic. It reacts

The 8012, shown full size at right, is a transmitter tube that delivers 35 watts at 500,000,000 cycles. Below is a slightly larger 300-watt tube

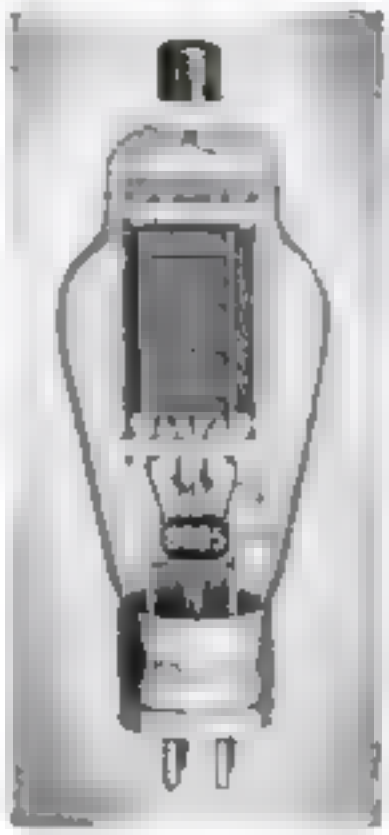
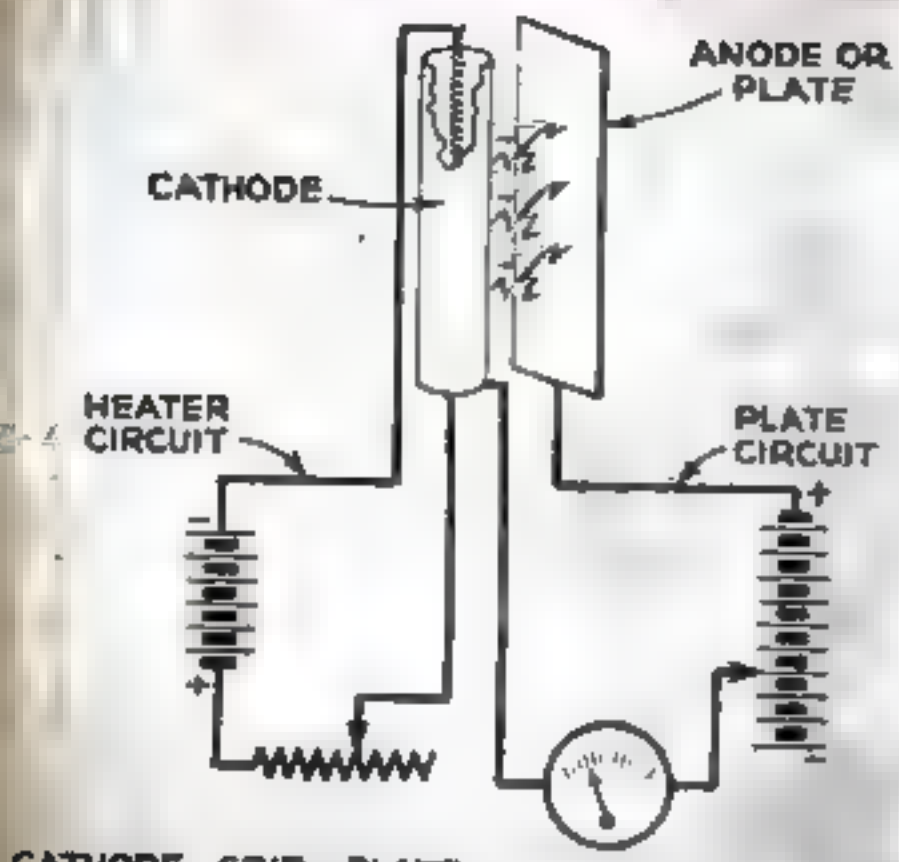


Fig. 1



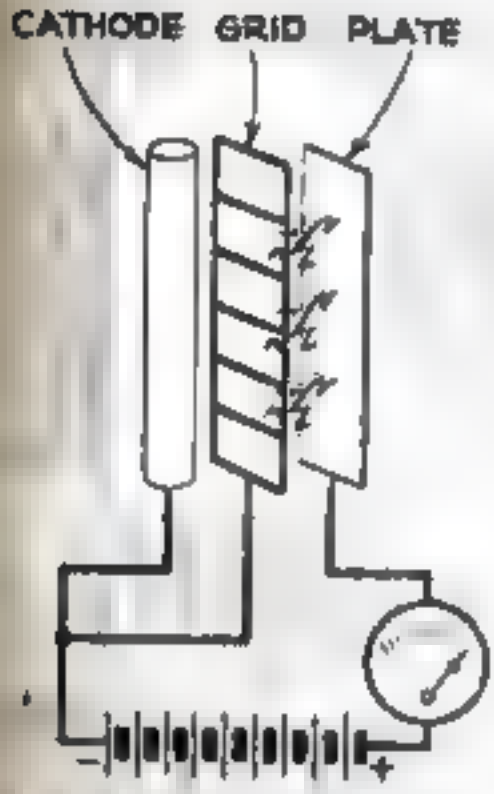


Fig. 2

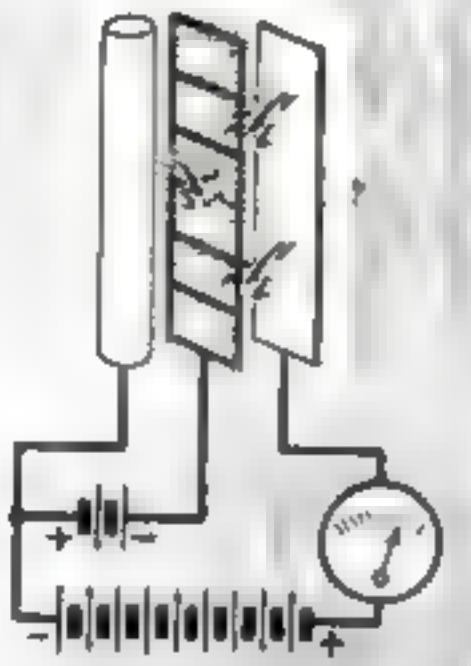


Fig. 3

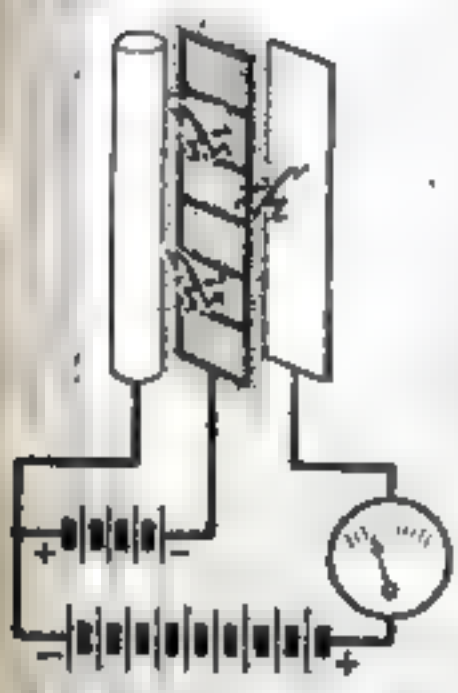


Fig. 4

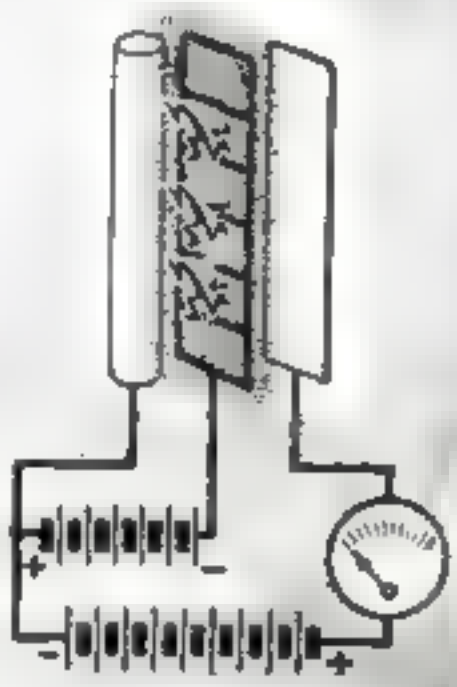
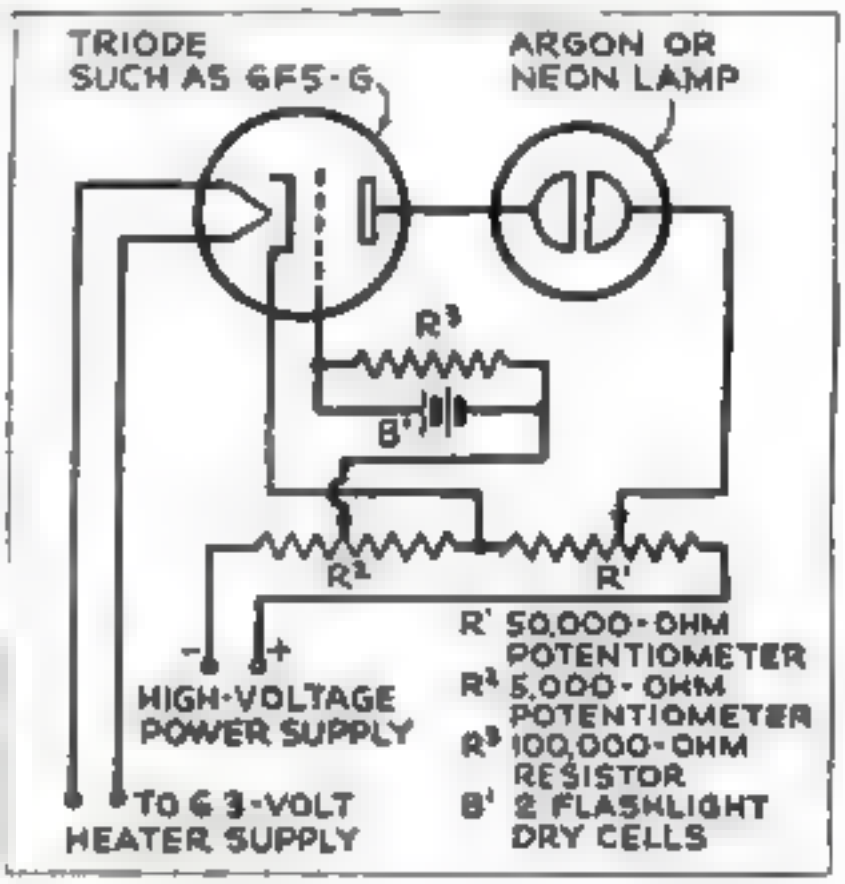


Fig. 5

This setup shows how grid changes affect the plate current. With a 275-volt power supply, 250 volts can be impressed on the plate and 25 on the grid. A few volts difference on the grid affects the lamp as much as a 100-volt change on the plate, the ratio indicating the amplification. Try varying the potentiometers and also reversing battery polarity. A glow spreads or diminishes on one plate of the neon lamp as the plate current increases or lessens



to changes in grid potential at almost the speed of light. Electrons have very little mass, hence very little inertia. They can be moved at tremendous velocities. Electrons can be impressed upon the grid of a vacuum-tube amplifier in a ten-billionth of a second and drained off as quickly. The plate current will respond to such changes in the grid potential faithfully, even though it may take more than a ten-billionth of a second for the electrons comprising that plate current to travel from the cathode to the plate. The plate-current variations would arrive a trifle later than the grid impulses, but all in correct order and properly spaced.

However, to charge and discharge a grid periodically, we must move electrons quickly and in great numbers. Small though their inertia is, pumping them into and out of a grid at high frequencies requires considerable power. The reason for this is that a grid constitutes one plate of a tiny condenser,

which in most small amplifier tubes has a capacity of only a few micromicrofarads. Now a certain number of electrons impressed upon a .001-mfd. condenser will produce a charge of, say, 10 volts. But the same number of electrons on a .01-mfd. condenser will charge it to only 1 volt. Therefore, the bigger the grid (that is, the greater its capacity) the more energy is required to pump electrons into and out of it.

A 1-mmfd. condenser will be charged to a potential of 1 volt by a current of 1 micromicroampere flowing for 1 second. To charge this same condenser to the same potential in a millionth of a second takes 1 microampere—a million times the current.

Radio amateurs working with short-wave equipment at frequencies up to 750 megacycles use very small "acorn" tubes in special circuits. At such frequencies, the capacitance even of a straight piece of hook-up wire becomes something to reckon with.

Triode Oscillator Generates Wide Range of Frequencies

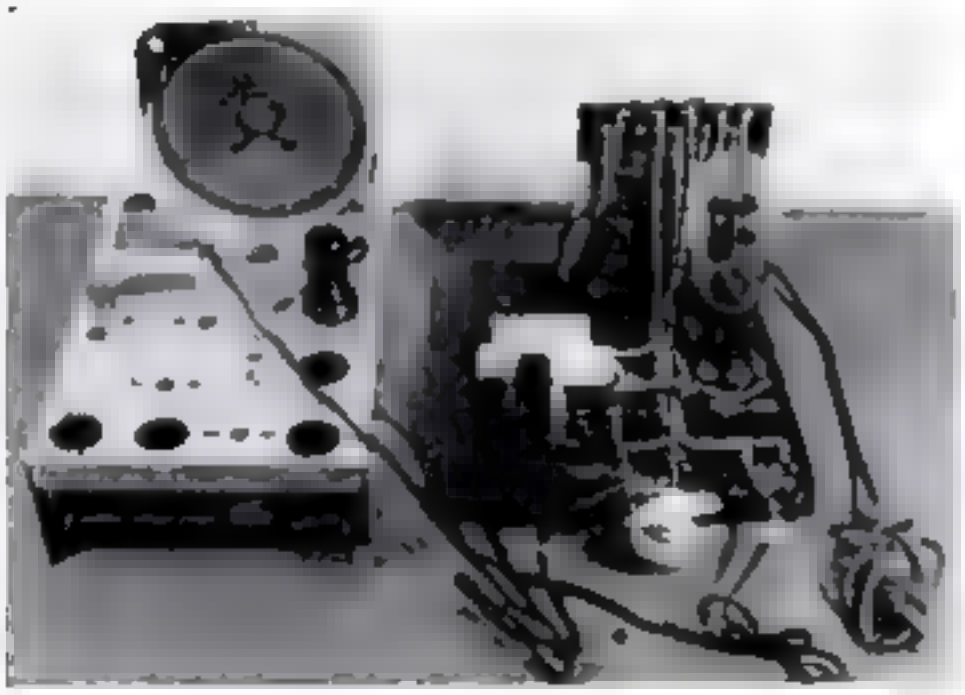
WITH the homemade oscillator shown below, you can generate audio frequencies ranging from the lowest to the highest audible to the human ear. The addition of a telegraph key makes the oscillator a useful code-practice set.

By impressing upon the grid of a triode the oscillating current of a resonant circuit, we obtain in the plate circuit a current of the same frequency. Since this same plate current flows in the cathode circuit, which includes the lower half of the inductance *L*, the varying magnetic field there created will induce a like oscillating current in the remainder of the inductance, thus maintaining the energy in the resonant grid circuit. With the proper values of capacity, inductance, and resistance, any desired frequency can be generated. When the resistance *R* is adjusted to zero, the circuit oscillates at a frequency given by the formula

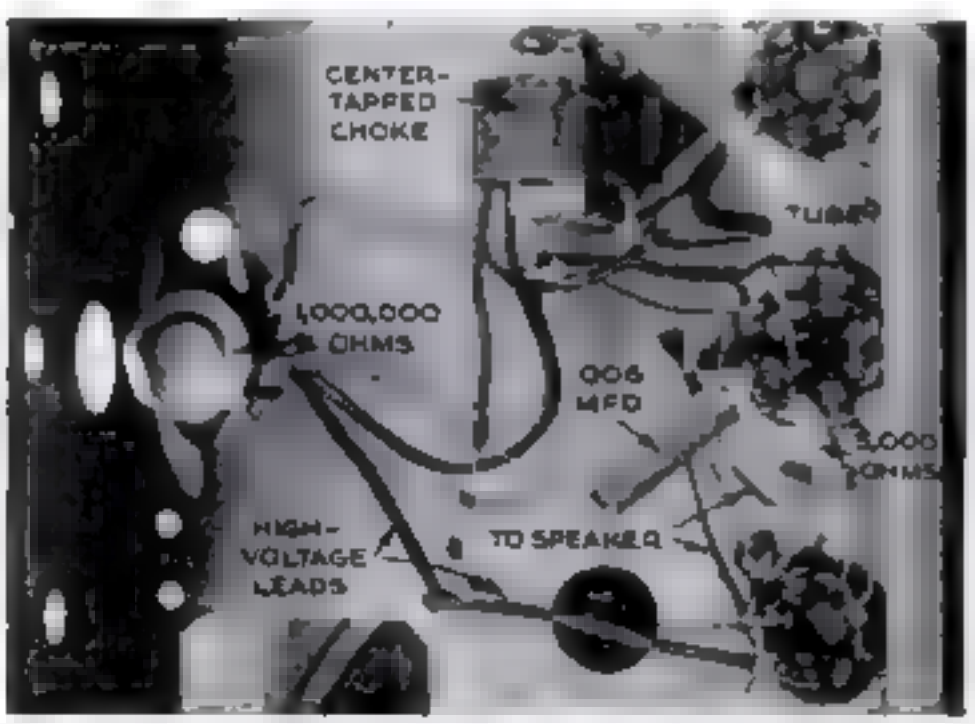
$$F = \frac{160}{\sqrt{LC}}$$

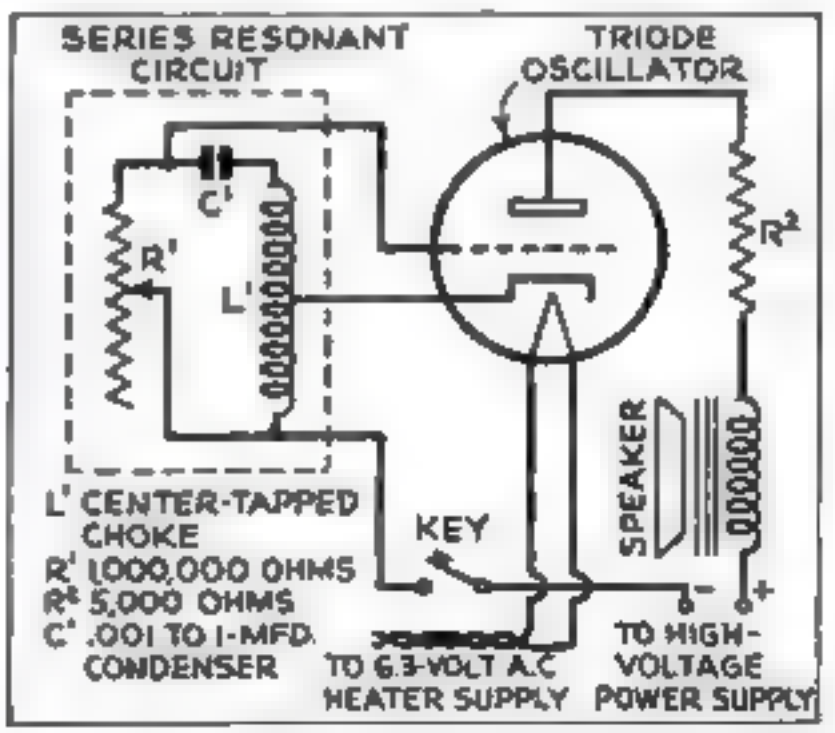
where *F* is the frequency, *L* the inductance in microhenries, and *C* the capacitance in microfarads.

With a center-tapped filter choke and a .001 to 1-mfd. condenser, a 1,000,000-ohm potentiometer tunes the circuit to various frequencies. If you have no center-tapped choke, you can use an audio transformer by joining a primary and a secondary lead so that current flows through both in the same direction. The juncture acts as a center tap, and the speaker-lead resistor can be omitted.



Mounted on an old radio chassis, the oscillator is powered by a high-voltage supply shown at the right of it. Below, the underside of the chassis



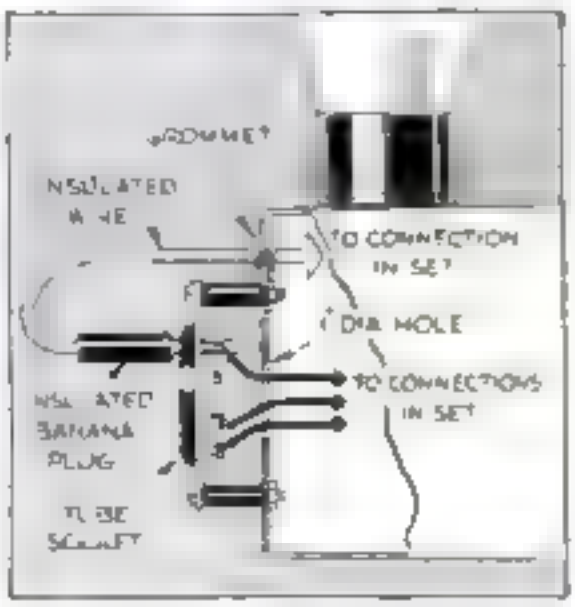


Servicing Your Radio

NOISY VOLUME CONTROLS of either the wire-wound or carbon type often can be repaired simply by removing them from the chassis and cleaning them thoroughly. Soak a piece of clean linen in ordinary noninflammable cleaning fluid and rub the windings and contact arm of a wire-wound control until they are clean. A little more care is necessary with a carbon control. Roll a small piece of absorbent cotton tightly around the end of a toothpick, dip it in the cleaning fluid, and wipe carefully, with a little pressure, along the carbon strip. Be sure also to clean the contact springs on the rotating arm.

SLIPPING IN THE TURNTABLE of a phonograph may cause difficulties that are sometimes incorrectly attributed to the motor. Look first at the rubber washer between the turntable and the motor spindle—the cone-shaped piece marked with an arrow in the photograph at left—for it may be to blame for the turntable failure. Frequently this washer becomes soaked with oil from the motor, and when this is the case, the washer surface is made so slippery that it cannot establish a firm contact with the turntable. Cleaning is rarely effective, and it is much more satisfactory to replace the old washer with a new one.

YOUR HANDS USED ALONE sometimes will serve to locate trouble in a balky receiver. For instance, if reception is weak, touching the grid cap of the converter tube —a tube such as the 6A8 or 2A7—with one finger and chassis with another, as indicated in the photograph, may make it come in louder. This will mean that the secondary of the antenna coil is open or that a corroded connection on the coil is causing an extremely high resistance in the circuit. Even persons shy of electricity need have no fear in making this test, for no shock will be experienced if directions are followed. Don't touch parts below the chassis.

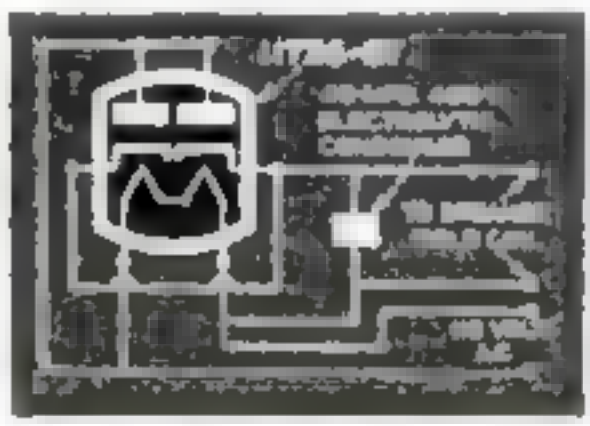


WAVEBAND SWITCHES and other switches in a receiver circuit may be replaced when they break down by using a four to six-prong tube socket and an insulated banana plug, as shown in the photograph at the far left. The socket may be mounted on the back of the chassis, following the directions detailed in the drawing. Two sleeves placed under it will raise it slightly from the chassis so that there will be room for insertion of the plug.

radio ideas

FM POLICE RADIO EQUIPMENT now incorporates "iron-core" or inductive tuning among other new features. The closely controlled movement of an iron core in and out of a small form-wound coil permits easier and more accurate tuning, and reduces the effects of car vibration on tuning adjustments. Likewise new is a "workbench" support which proves convenient when the chassis is inverted for inspection or repair. Test jacks permit direct, simultaneous readings of several functions at one time. All tube sockets and tuning controls are stenciled on the top of the chassis.

A MIDGET RECTIFIER for energizing any electrodynamic speaker having a high-resistance field coil can be made as shown in the accompanying diagram. This will permit substitution of such a speaker in a circuit originally calling for a permanent-magnet speaker. One of the advantages of the midget rectifier is that it is small enough to fit any radio chassis and therefore can be used in a wide range of circuits in which such a speaker is to be supplanted. It will provide the current necessary to operate an electrodynamic speaker if it is equipped with a rectifier tube capable of carrying at least 150 milliamperes, and is a handy expedient when a permanent-magnet speaker is not available.

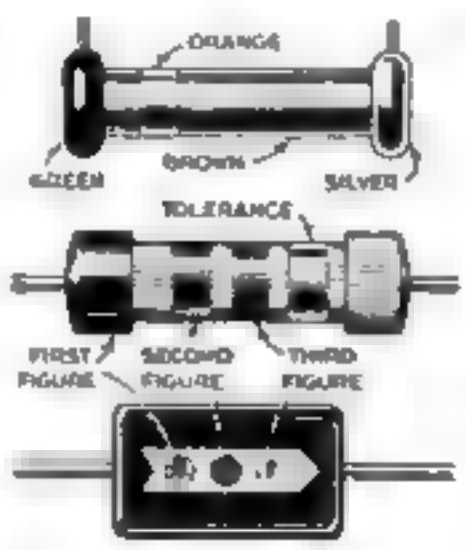


RESISTOR AND CONDENSER CODES [ELECTRICAL]

Small carbon resistors and small mica condensers required in a modern radio set are too small for convenient labeling with numerals so the Radio Manufacturers Association has adopted a standard code-marking system, a color code. Digits are represented by colors as follows:

0	Black	5	Green
1	Brown	6	Blue
2	Red	7	Violet
3	Orange	8	Gray
4	Yellow	9	White

Two types of markings are used on resistors. The straight-end, tubular-type resistor, with leads coming straight out of the end, is marked with color bands. The band at one end represents the first digit, the next band gives the second digit, and the third band gives the number of zeros. That is, if the bands are brown-green-orange they are read 1-5-three zeros, or 15,000 ohms. This straight-end type sometimes carries a fourth band either gold or silver. This band indicates the accuracy of value, gold being the highest.



The second type of resistor with leads coming out at right angles—uses the body color for the first digit, tip color for the second and a dot or band at the center for the number of zeros. Thus brown body, green tip, orange band should be interpreted as 1-5-000 or 15,000 ohms.

Condensers use the same type of color coding but the readings are in micromicrofarads, and the color is applied in small dots with an arrow indicating the order in which they are to be read.

POPULAR SCIENCE MONTHLY SHOP DATA

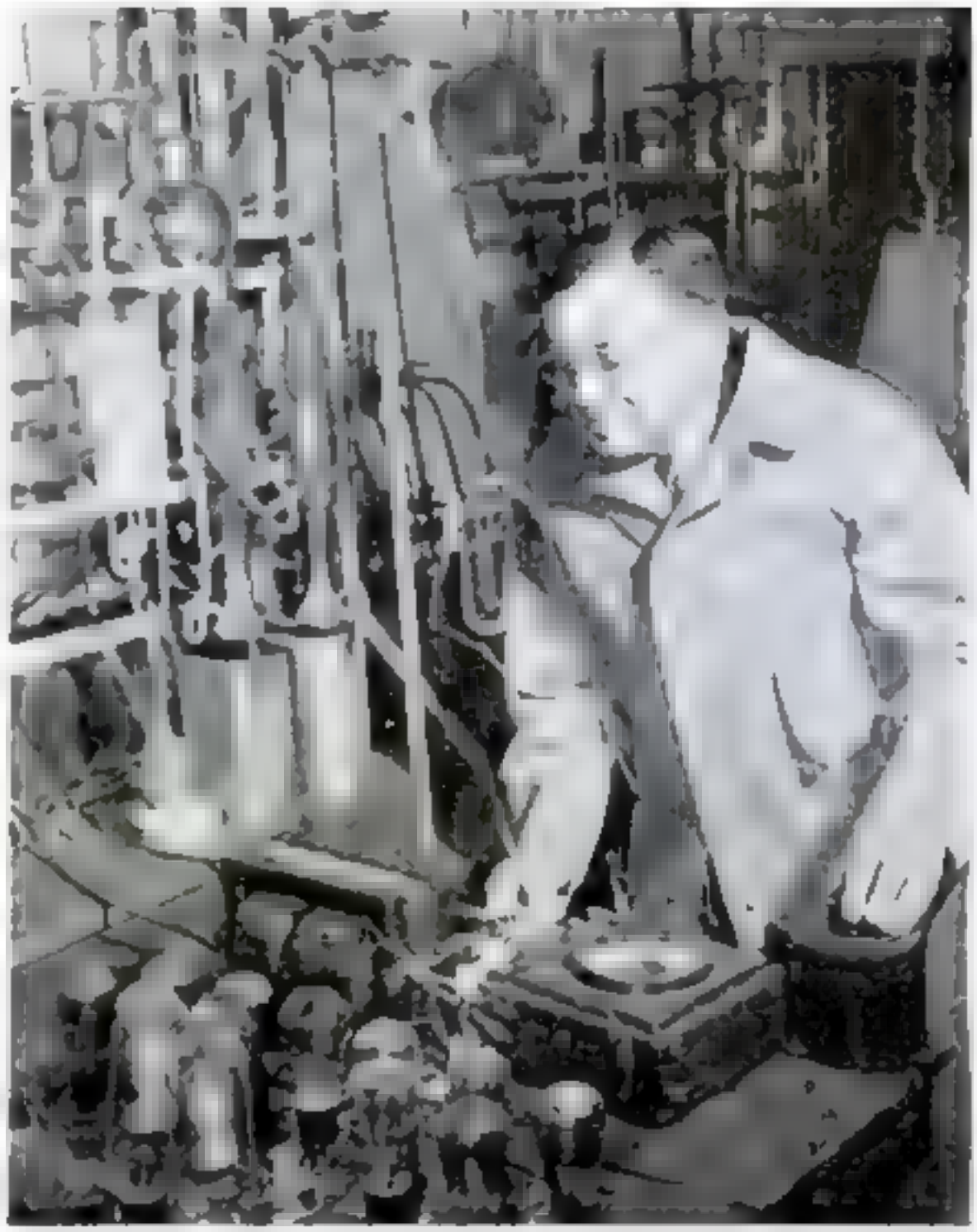
Dissolved Oxygen Reduces Power Needs and Increases Life of Electron Tubes

THE recent solution of a long-standing electronic mystery promises new radio tubes which will have both longer operating lives and reduced power requirements. Similar improvements are foreseen for other electron tubes.

It is the purpose of a vacuum-tube cathode, of course, to discharge a volley of electrons to the plate. For 40 years scientists have known that an oxide-coated cathode emits electrons more readily than a pure metal one, but they haven't known why. Now Dr. Harvey C. Rentschler, Westinghouse research expert, has an answer.

Atoms of oxygen, he finds, apparently distort the crystal-lattice structure of the cathode and thus enable the electrons to be shot off more easily. Moreover, a method has been discovered by which oxygen can be dissolved within the metal of the cathode, much as salt can be dissolved in water. In previous practice, certain types of cathodes have been made by forming oxides of various metals into a paste and baking the paste on tungsten supports. The procedure developed by Dr. Rentschler consists of heating cathodes of zirconium, titanium, thorium, or caesium in oxygen until a "solid solution" of oxygen is uniformly distributed throughout the metal.

High-voltage vacuum tubes offer a special application of this new technique. Hitherto the cathode of a high-voltage tube has had to be made without an oxide coating because the strong electric field would rip the coating from its support. Oxygen dissolved in the cathode, however, is an integral part of it and can't be pulled off.



Within the glass tube is a strip of zirconium which Dr. Rentschler is treating with oxygen to improve its electron-emitting characteristics

Below, a photoelectric cell having one of the new cathodes is tested by a spectroscope. Electron emission is caused by both light and heat

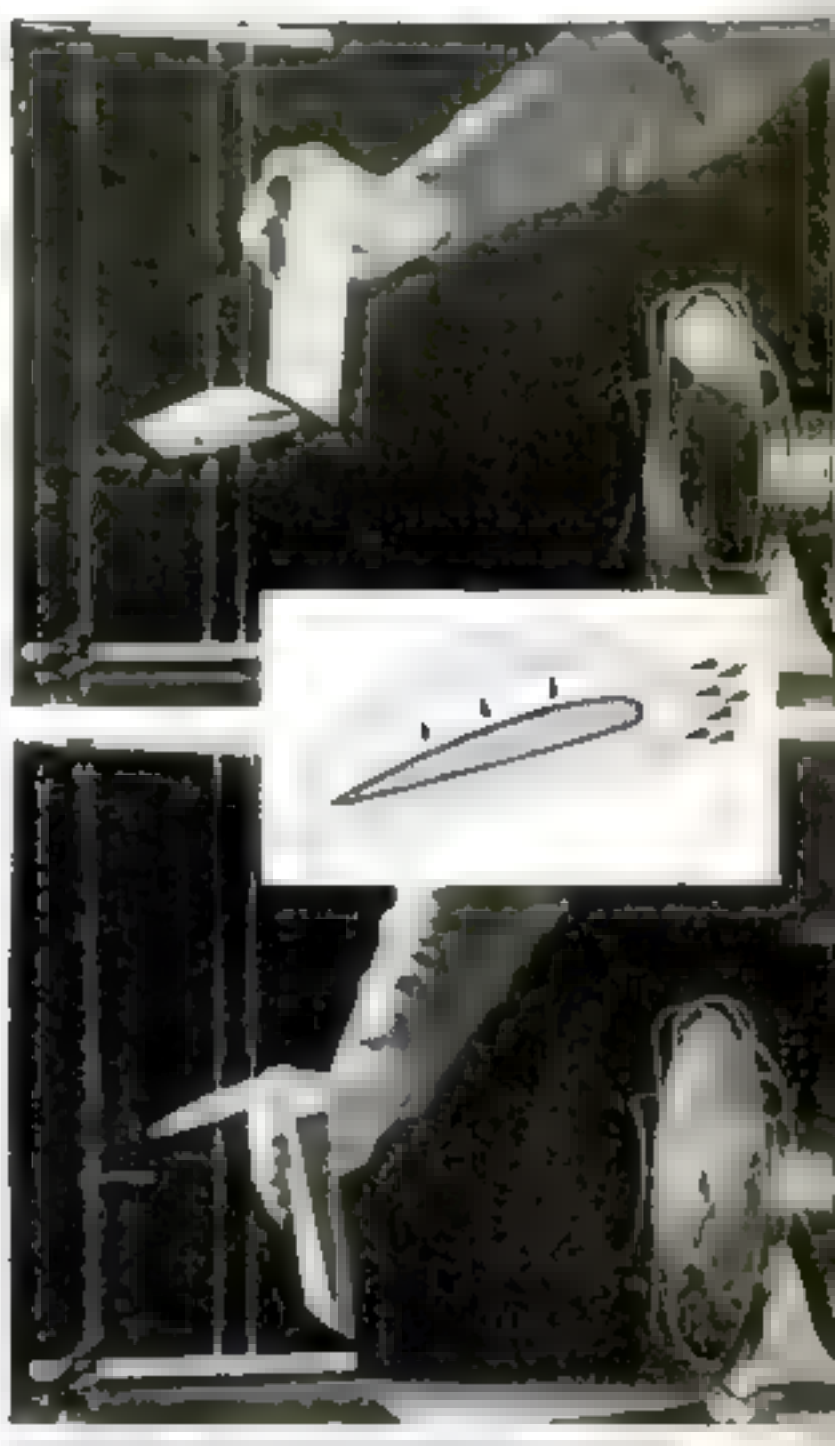
How Airplane Wings Get Their Lift

WHAT gives an airplane its lift? Near the beginning of the eighteenth century, a Swiss mathematician, Daniel Bernoulli, discovered a physical principle which accounts for the greater part of the answer. In the course of experimenting with fluids, both liquids and gases, he found that pressure decreases as velocity increases.

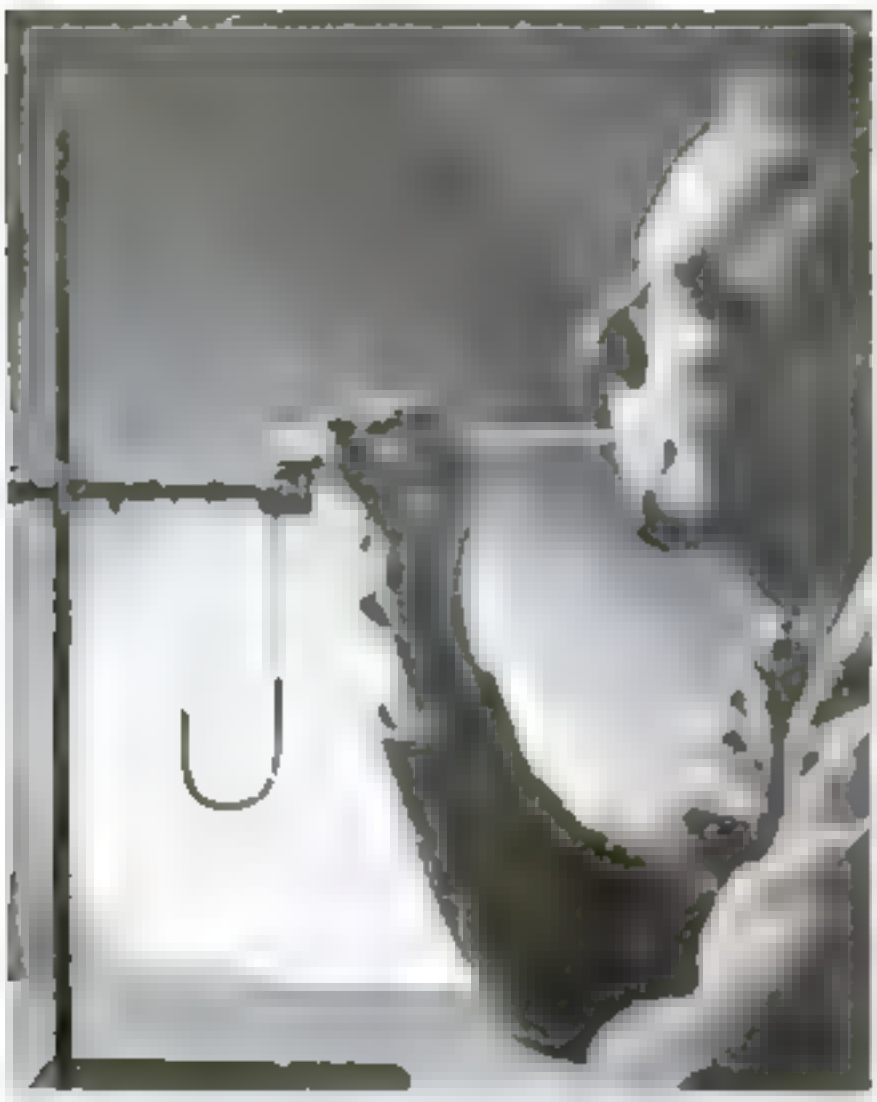
The Bernoulli principle explains the increased draft of a chimney when wind blows across its top, the bursting of a house near the path of a tornado, the curve of a ball that is spun as it is thrown. It is also one of the most vital factors in aerodynamics, ac-

home EXPERIMENTS

AN AIR STREAM directed in the space between two freely suspended oranges will result in lowered air pressure in this area. The outside air pressure will thereupon force the two oranges together. Suspend the oranges so that they are about 1½" apart when hanging at rest.

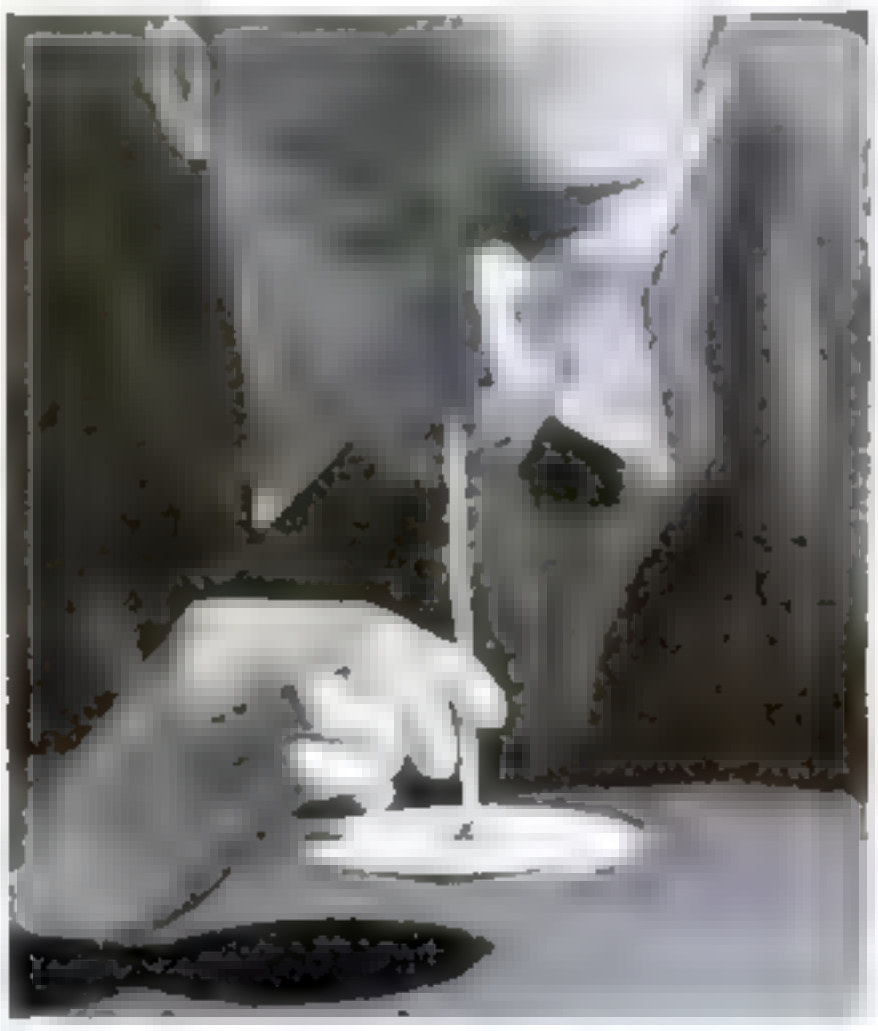


MAKE THIS AIRFOIL by covering a cardboard-and-dowel frame with paper. Holes are needed in the paper to enable the airfoil to move freely along the guide wires as pictured in the photographs above. Stops on the wires cause the airfoil to rest normally just a little below the center of the slip stream from the fan. To show that the airfoil gets more lift from the partial vacuum above the wing than from the air stream under it, hold a strip of cardboard under the leading edge so that only the under surface is exposed to the breeze of the fan. The airfoil will rise a little. Then make a second test by holding the cardboard in such a way that the fan blows only above the airfoil, which now rises much higher.



A MANOMETER, a device used for measuring gas pressure, can be made by partly filling a bent glass tube with colored water. The level in both sides is normally the same, but when you blow through another tube squarely across one open end of the manometer, the water rises in that leg, showing that the air pressure on that side is reduced. As you blow harder, increasing the speed of the air flow, the water rises higher. Similar manometers are used in determining pressures on the various parts of airplane wing surfaces and on the wings of test models. Atomizers work on the same principle.

counting for nearly 75 percent of the total lift exerted by an airplane wing. Air passing rapidly over the curved upper surface of a wing reduces pressure there, causing a partial vacuum. The relatively greater pressure beneath the wing then buoys it up. This may sound mysterious, for the idea that lift comes from a partial vacuum above a wing is not the most obvious explanation. But by performing the accompanying simple experiments, you can prove to yourself how the Bernoulli principle plays a part in modern aerodynamics.



CUT TWO DISKS of cardboard about 4" in diameter. Make a small hole in the center of one and seal the end of a drinking straw over the hole with sealing wax. Push a pin through the center of the other disk. Hold the first disk about $\frac{1}{2}$" over the other with the pin sticking up into the straw. Blow hard through the straw, and the lower disk will jump up to the other. The harder you blow, the more firmly the disks stick together, since the air rushing between them reduces internal pressure while external pressure remains the same.

A TABLE-TENNIS BALL bounces up and down if supported on an air stream, but it won't fall to one side. As it tends to do so, the air stream creates a low-pressure area on the opposite side, and atmospheric pressure moves it back.

Magical Tricks

WORKED WITH CHEMISTRY

Simple Home Demonstrations To Mystify Your Friends

By KENNETH M. SWEZEY

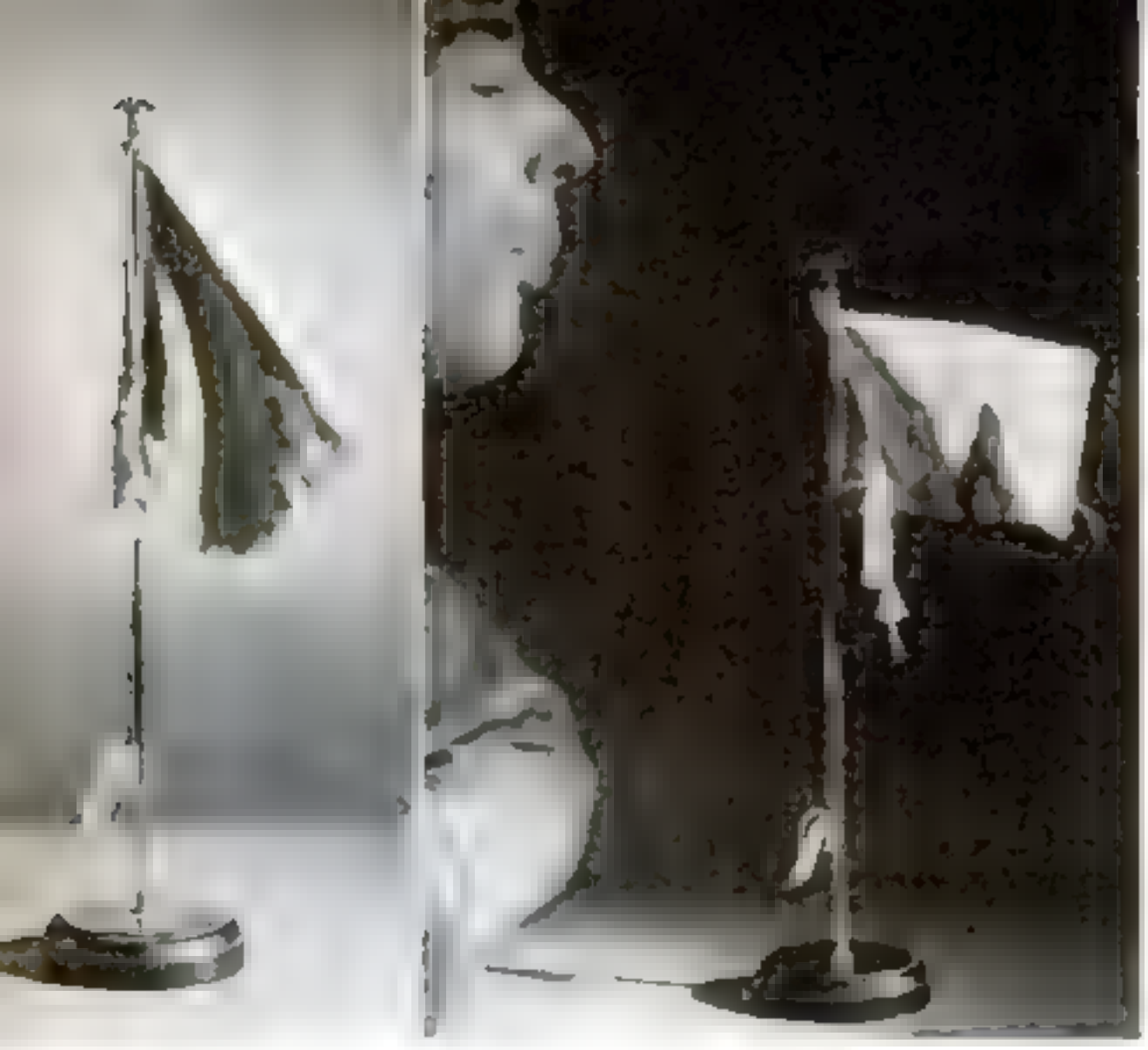
ALTHOUGH it may be a far cry from the ancient alchemist's den to the modern laboratory, chemistry is still a science of amazement and seeming magic. Everyone who professes to be a chemist, amateur or otherwise, is expected by his lay friends to be able to conjure up wonders at the slightest notice.

For personal pleasure, and to gratify these friends, every home chemist ought to develop a little "curiosity shop"—a collection of exhibits and fascinating stunts with which he can entertain visitors. Items for this shop can be both permanent displays and tricks that can be performed with the minimum of preparation. A few suggestions follow, but every installment of this home chemistry series contains at least one stunt that could well be included in your repertory of wonders.

A "silver tree" that can either be "grown" before the spectator's eyes or be set up as a semipermanent exhibit will make a beautiful and instructive feature. Merely dissolve 3 grams silver nitrate in 60 ml. distilled water and pour it into a 2-oz. bottle. Carefully clean and scrape a roll of tin foil about 1½" long and ¼" in diameter, and suspend it from the stopper of the bottle. In a few minutes glittering crystals of pure silver will be deposited over the surface of the tin foil. Being chemically more active than silver, tin drives the silver out of the silver nitrate and replaces it. The crystals of silver keep growing until all the silver in the solution has been replaced. They will remain on the tin-foil core until jarring dislodges them.

A miniature flag that responds as a humidity indicator, and may be changed

Here is a puzzler guaranteed to make spectators gape. A beaker or thin glass containing crystals of ammonium nitrate is set on a damp block of wood. Simply by adding water and stirring vigorously, the beaker can be made to stick tight. As the crystals are dissolved the beaker becomes intensely cold and the drops under it freeze solid



Colored in a solution of cobalt chloride, this little flag is a bright blue when it is perfectly dry. Blow on it, however, and it turns pink as it absorbs the moisture from your breath. Its ability to register quickly a slight change of moisture in the air makes a flag of this kind an excellent indicator of humidity

from bright blue to pale pink merely by blowing on it, is another stock exhibit that may be made in a few minutes and will always arouse interest. Soak a piece of white cotton goods in a solution of cobalt chloride. While this cloth remains wet, or is even moist from humidity, it will be pink, but as it dries, its color changes to light blue and then to deeper and deeper shades of blue. Mount the cloth on a little flagstaff. Before demonstrating the trick, warm the flag slightly in order to make it the deepest blue. By blowing on it for a minute or so, you can turn it pink as the crystals of cobalt chloride absorb moisture from the breath.

Strips of white paper can be made to turn pink or red when held in what appears to be an empty glass, and then to turn white again when removed. Prepare a supply by soaking strips of blotting or filter paper in phenolphthalein solution and allow them to dry. To work the stunt, moisten a strip in plain water and hold it in a glass that has just been rinsed with household ammonia. In the presence of the ammonia, the phenolphthalein gives its usual reaction to a base, turning pink or red, but returned to fresh air, it loses its color.

A beaker or thin glass containing 60 grams ammonium nitrate will enable you to perform a feat that will get a sure-fire response. Put a dozen drops of water on a wood block and place your beaker in the center of the puddle. Now stir in 60 ml. of water (as cold as you can get it), attempting to dissolve the chemical as quickly as possible. During this process the beaker will become extremely cold and in a minute or two will freeze fast to the block. A thin coating of oil smeared inside the beaker above the solution will allow the water to evaporate eventually of its own accord and keep the chemical from creeping over the top of the beaker. When the crystals are dry, the stunt may be repeated.

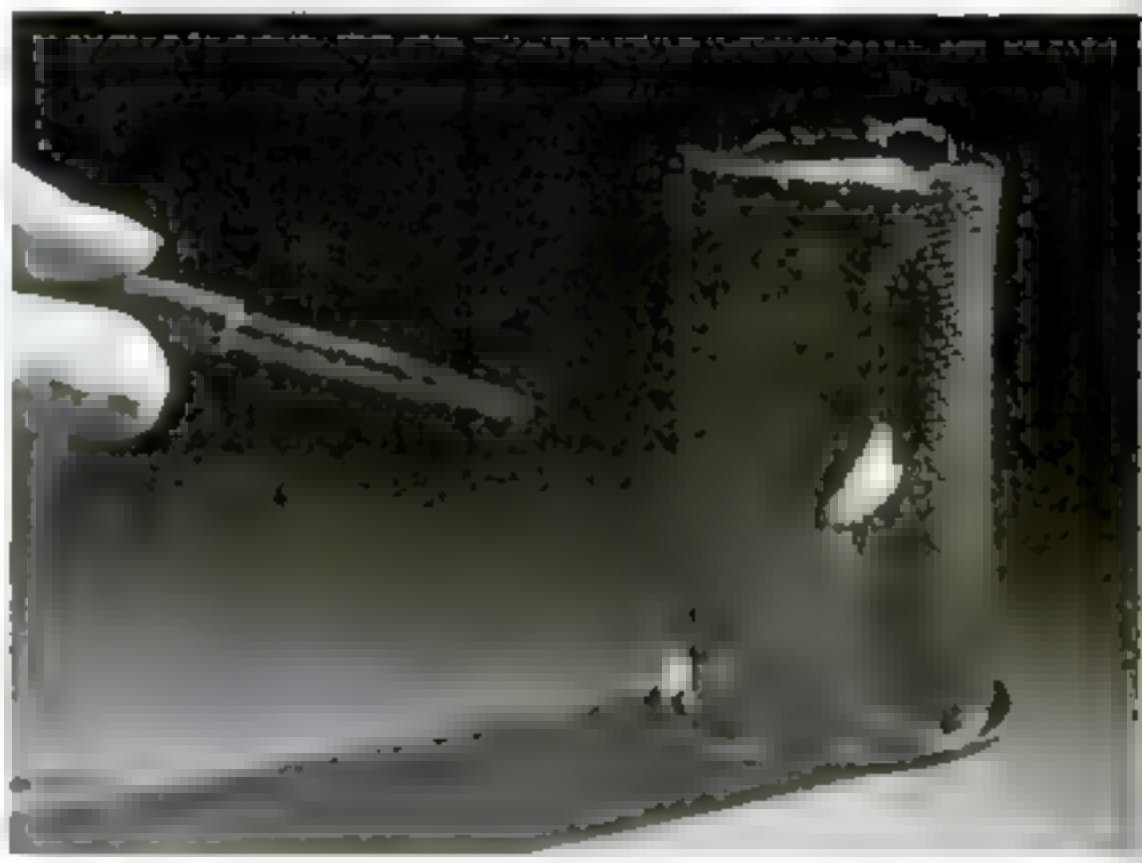
You probably know the dinner-table stunt of boiling water on a visiting card with turned-up edges. The match or candle flame used does not burn the card because the water keeps the latter below the temperature of combustion. With care, tinfoil and lead foil may be melted similarly on a card.

The safety lamp, invented by Sir Humphrey Davy to prevent the explosion of free gas in coal mines, makes use of the same principle. In this case a screen of fine wire gauze surrounding the flame prevents igniting of outside gas by limiting the heat that gets through. A model of a safety lamp can be made from metal netting soldered or sewn to form a tube 6" long and 2" in diameter. Fasten on a top of the same material. If copper gauze of 30 or 40 mesh is used, only one layer will be required. Coarser netting, such as ordinary window screen, may require three or four layers. A jar cover forms the base, and a birthday-cake candle the light. Direct a stream of illuminating gas from a small tube toward your safety lamp. The gas will not ignite outside the screening, though it may catch fire within the lamp.

A little ball of steel wool that floats and sinks apparently without rhyme or reason is another good puzzler. Fill a tall tumbler or glass cylinder with a water-clear solution made up of 1 part sulphuric acid and 6 parts water. Compress a little wad of fine steel wool to the size of a marble and drop it into the solution. First it will float because of air trapped in it; then it will sink as the solution penetrates. Suddenly, however, it will rise again, then fall, and go through unpredictable gyrations.

To the chemist, the cause of the rising and sinking is obvious. The iron liberates

As a finale for your home exhibition of chemical magic, put a little potassium thiocyanate in the bottom of a tumbler, some silver nitrate in another, a few drops of potassium ferrocyanide in a third, and ferric chloride and water in a pitcher. Pour this last into the glasses. The first will become red, the second milky white, and the third blue

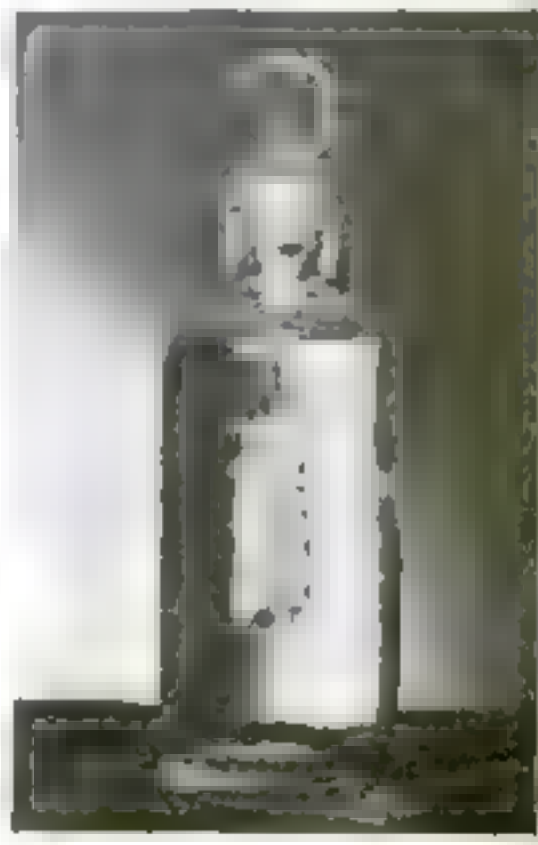


hydrogen from the dilute acid. This clings to the ball and buoys it up, but as some of the gas is lost, the ball drops again. If the ball doesn't rise, fluff out the steel wool; if it doesn't sink, compress it further.

For an astonishing—and patriotic—finale, prepare four little dropper-top bottles, each containing a solution of potassium thiocyanate, silver nitrate, and potassium ferrocyanide, and ferric chloride, dissolving 10 grams of each chemical in 60 ml. water. Into the first of three tumblers put 10 drops of potassium thiocyanate; into the second, 10 drops of silver nitrate; into the third, eight drops of potassium ferrocyanide. These solutions are clear and will not be noticed at the bottoms of the glasses. The ferric chloride solution, however, is yellowish, so about 15 drops of it are put into a tinted or opaque pitcher, together with three glassfuls of plain water

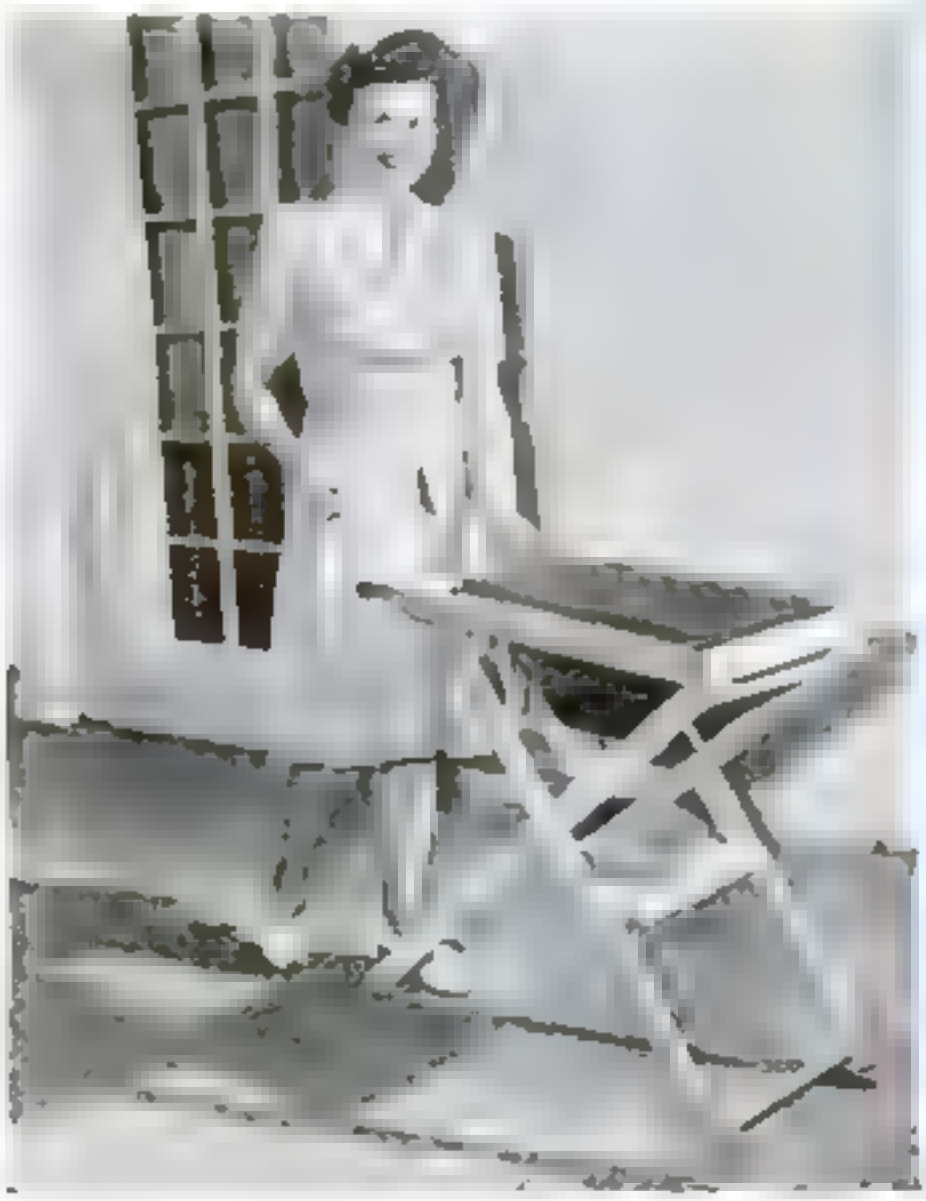
Pour the solution from the pitcher into the first glass, and it instantly becomes red; pour it into the second, and it becomes white; pour it into the third, and it becomes blue!

Made of ordinary wire gauze or screening, the little lamp above will demonstrate the effectiveness of the miner's safety lamp invented by Sir Humphrey Davy. A jet of illuminating gas directed toward the flame will cause it to flutter, but will not ignite outside the lamp. The wire gauze cuts down the intensity of the heat passing through to prevent combustion



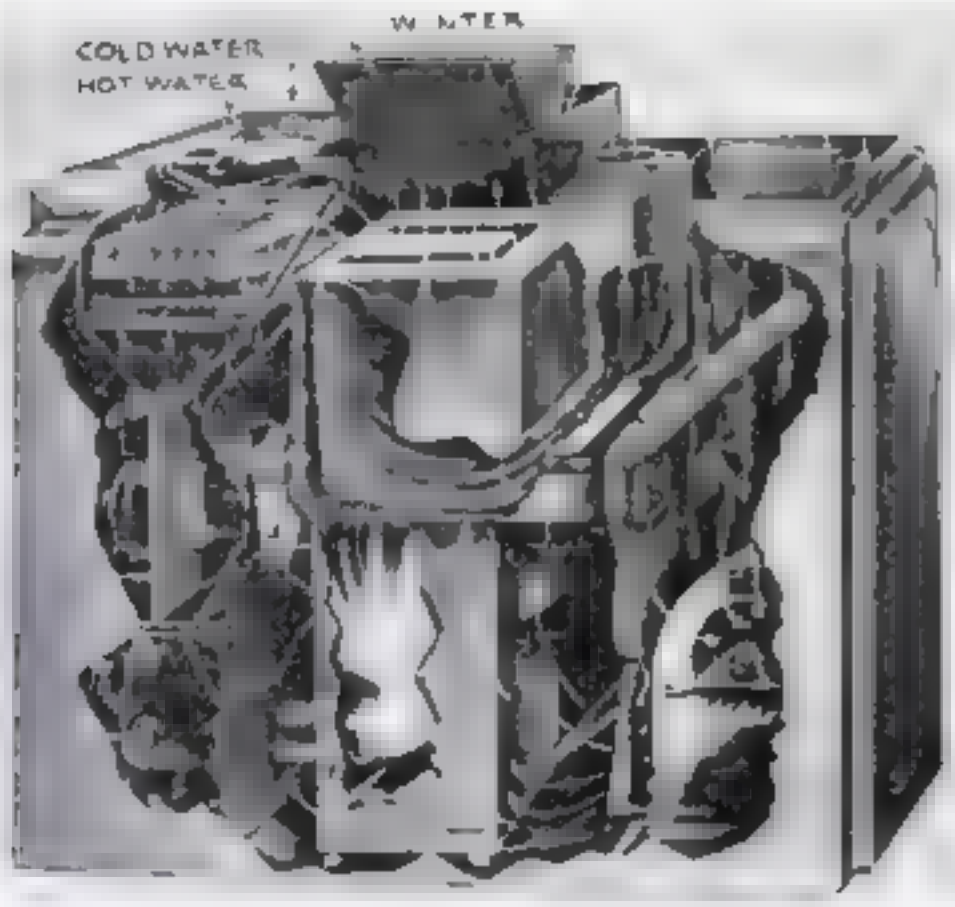
Literally made to grow before the eyes of your friends, the little "silver tree" at right presents a pretty sight. It is a small roll of tin foil in a solution of silver nitrate. Tin is more chemically active than silver, and suspended in the solution it replaces the silver, which is deposited on the roll in glittering crystals as it is freed. This continues until all the silver is used up

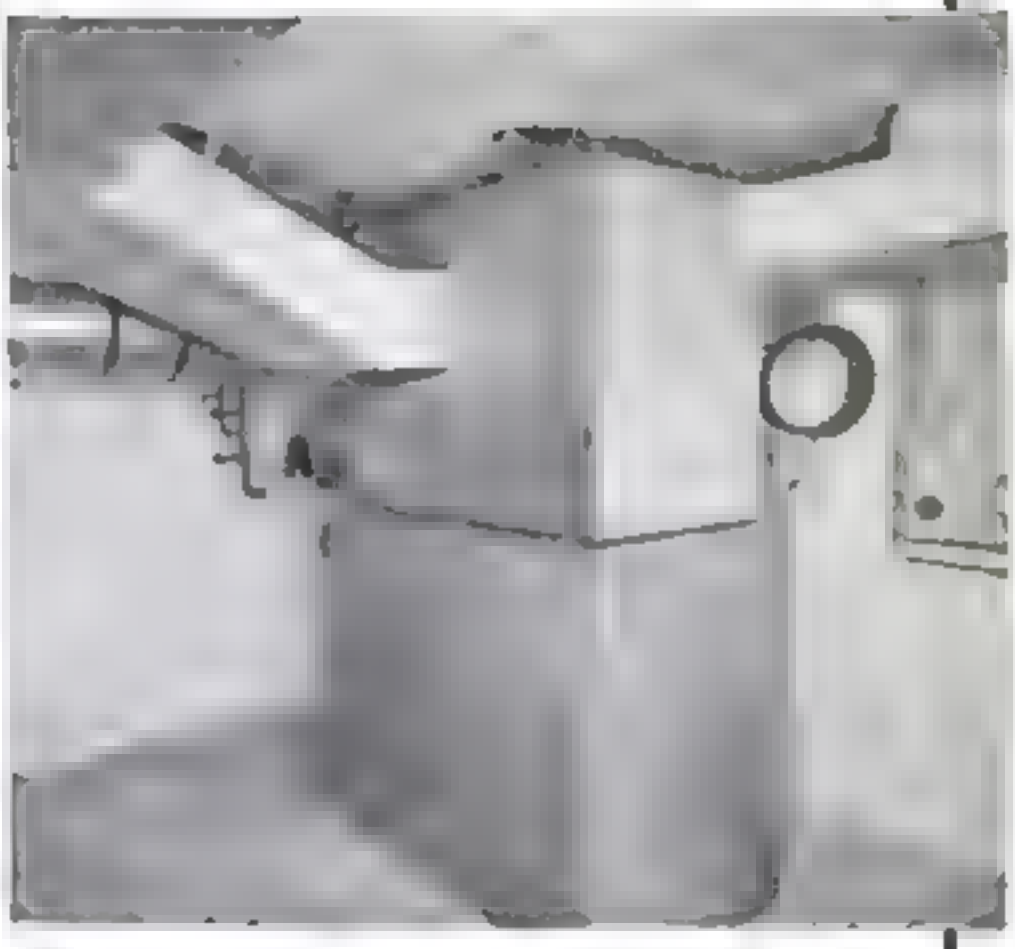
GARDEN TOOL SHEDS prefabricated of insulating wallboard for quick assembly are waterproof, fire resistant, and vermin-proof. They consist of seven parts, including four walls, a floor, and a two-part roof. There are three sizes, from 4′ by 6′ to 10′ by 12′, and they can be used on the beach as cabanas or as back-yard playhouses for children.



NEW SHOWER CABINETS are made of noncritical materials for quick assembly on the job. The cabinet has less than one pound of metal in it. All walls are made of hard pressed wallboard covered with baked enamel resistant to high temperatures. The receptor is made of green plastic. Complete equipment is included with the cabinets, even to the curtain.

COOKING ON GLASS proves quite practical with this portable grate and grill. It is made of glass that has been fired black, powdered to a fine dust, then molded into the grill and basket grate. A folding frame made of wood is coated with fire-resistant glass to render it safe from flame. The grill surface measures 12" by 19". Any kind of fuel may be used, although charcoal is, of course, ideal for the purpose.





HOME HEATING may be revolutionized by a new furnace recently invented by Corporal Harry Giffords of the Army Air Forces. The automatic unit furnishes hot water the year around, heats and circulates air in cold weather, provides circulation of outside air during hot days, and filters the air at all times. One of the unusual features of the operation of this unit is that it imparts heat from heated air to water, and uses the water so heated to furnish the domestic hot-water supply.

In summer the unit heats air that in turn heats water for storage or for immediate use without interfering with the circulation of cool outside air. An artificial cooling unit can be added if desired. The furnace is said to be economical to operate. Its principle has been suggested for possible use on large postwar air liners.

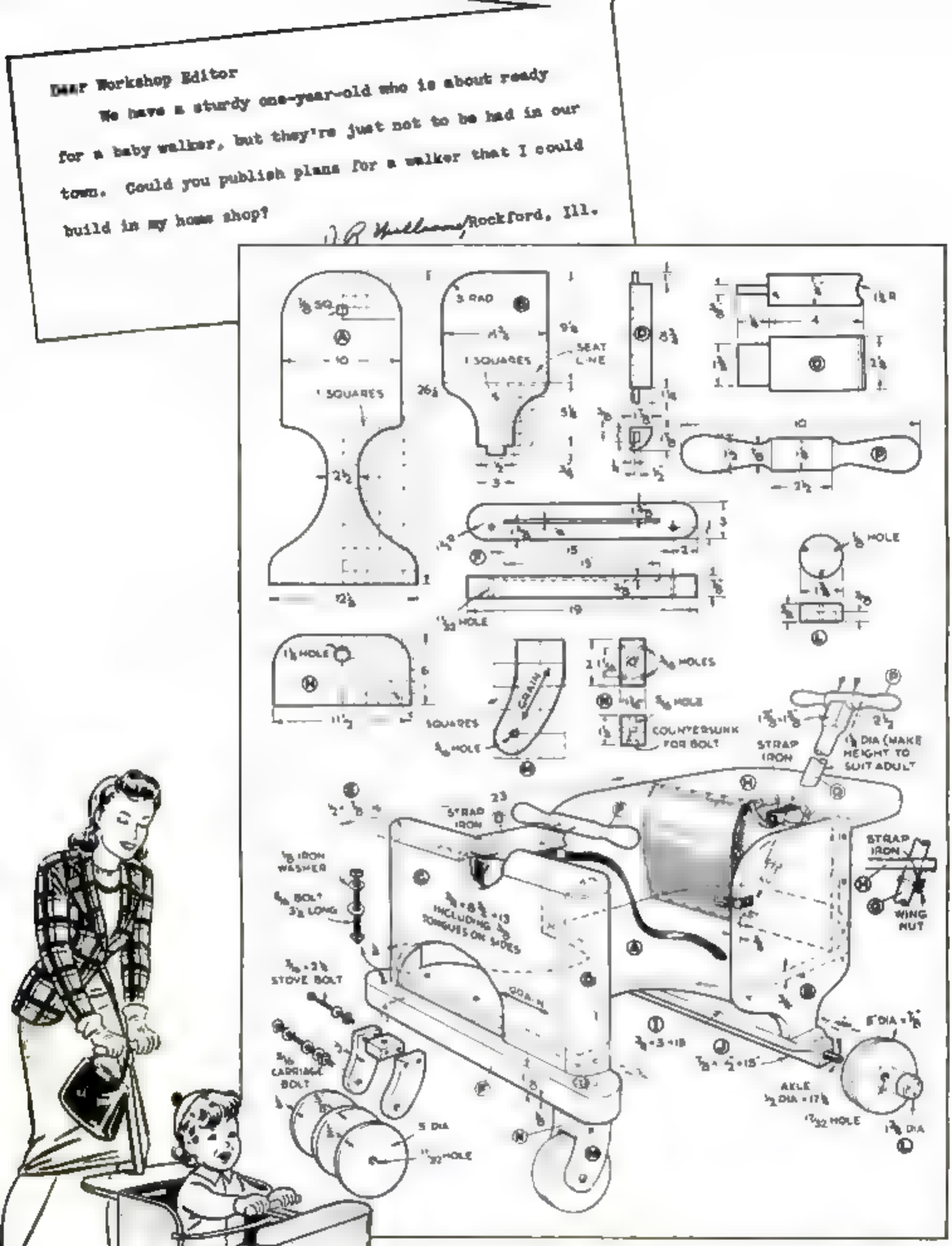
PRESERVING METAL that is about to rust through and become useless, such as gutters on a house or water buckets, is a simple matter with a new solution. The metal is cleaned of rust and dirt to begin with; then the solution is painted on, leaving a thick coat. This liquid is noninflammable and can be used indoors or outside. Objects treated with the solution should be allowed a week to dry, after which they may, if desired, be painted with any good-quality oil paint.

COMBINATION LADDER. A compact ladder that folds small enough to go into the luggage compartment of a car can be used as a long extension ladder, a small or a large stepladder, or as a support for a scaffold. In the photo above one such ladder is shown extended and another in use as a stepladder. The rails and rungs are of hardwood. Rigidity in all positions is assured by a patented double-lock design.

Dear Workshop Editor

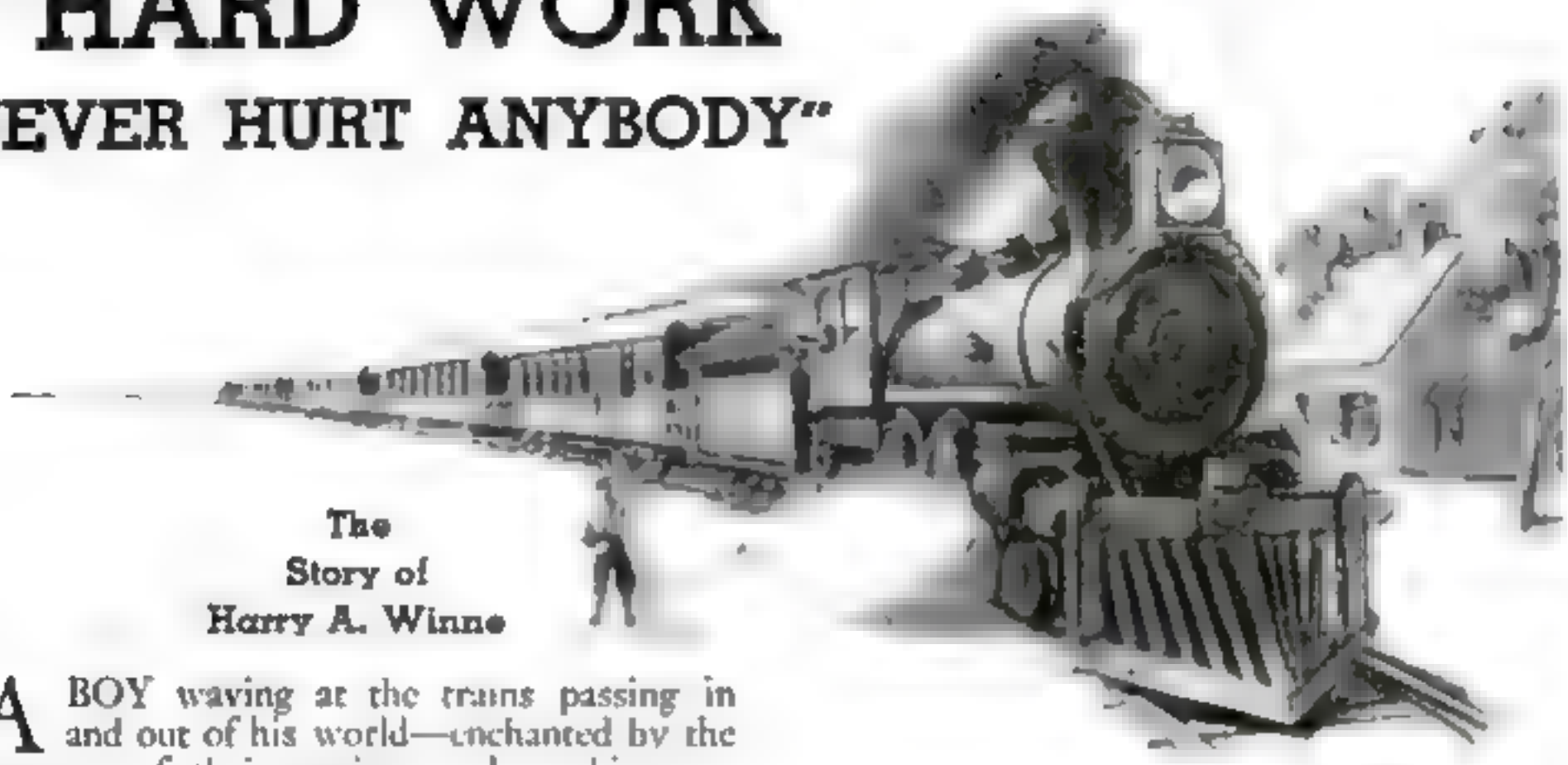
We have a sturdy one-year-old who is about ready for a baby walker, but they're just not to be had in our town. Could you publish plans for a walker that I could build in my home shop?

D. R. Williams, Rockford, Ill.



This walker, by Franklin H. Gottshall, can easily be altered to suit makers' tastes. Thus if it's used as a stroller, a detachable floor might be devised to keep the child's feet off the ground. Be sure that the grain of each wheel disk is 120 deg. from that of the other two disks. Don't finish with white lead paint, since it might be poisonous for teething children

"HARD WORK NEVER HURT ANYBODY"



The Story of Harry A. Winne

A BOY waving at the trains passing in and out of his world—enchanted by the mystery of their engines and machinery—that was Harry A. Winne.

He just *had* to know what made their wheels go round, and he was about knee-high to a brakeman when he started to learn. He'd hurry home from school to run the steam engine in his father's laundry. Soon he tore a small magneto apart and from it built an electric motor.

He knew he was going into the electrical business somehow; he thought maybe he'd become a lineman for an electric power company. So he and a blacksmith made metal climbers, and he learned to climb the telephone poles outside the grocery store where he was clerking.

But the teachers in the upstate New York town urged him to go to Syracuse University to study engineering. So Harry Winne started working harder. Summers he worked in a creamery; at other times he delivered the college newspaper and was Sunday watchman at Woolworth's. Studying as hard as he worked, he was graduated at the head of his engineering class in 1910.

At once he joined General Electric as a student engineer in the testing department, Schenectady. There he could watch some of the biggest wheels in the world go round, and in two years he was made assistant general night foreman.

"There are things higher up for you, Harry," his boss said before long. "You've got everything you can get here. You're destined for higher things."

And up Harry Winne went—through various engineering departments, to head of the steel mill section in G.E.'s industrial engineering department, to manager of sales of the combined mining and steel mill section—and then finally, a couple of years ago, to vice president in charge of design engineering!

Harry Winne'd tell you he got up there by hard work and luck. Today he's working harder than ever—at G.E. supervising the design of electric equipment for the army and Navy, at home in a big Victory garden beside his made-over farm house on a dirt road outside Schenectady.

But then—"hard work never hurt anybody!" *General Electric, Schenectady, N. Y.*

Hear the General Electric radio programs: "The Hour of Charm" Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

The best investment in the world is in this country's future BUY WAR BONDS.

GENERAL ELECTRIC

Buy War Saving Bonds and Stamps regularly.

HW 571

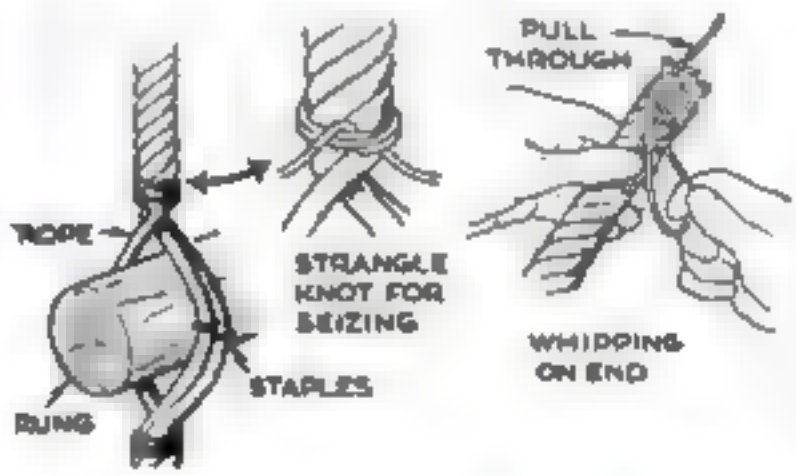
Easily Made Rope Ladder Is Useful Emergency Equipment

Wrapping an arm and a leg around a rope ladder gives support to the body in climbing. At right are shown details in the construction of a ladder

WHEN an emergency strikes, rope ladders are often highly desirable equipment, since they may be quickly put in position and are not hard to use. A feature which makes them especially convenient is that they can be rolled up for compact storage. They are also handy for access to a loft or attic where room does not permit installing a stairway.

These ladders are easily made from strong rope, 18" lengths of oak 1¼" in diameter, and twine. The rope may be used in two pieces or doubled. Unlay the strands at equally spaced intervals 12" to 18" apart, insert the rungs, allowing 1" to protrude, and hold them fast with staples. Bind twine above and below the rungs.

Whip the rope ends by forming a circle of a 15" length of twine, with ends overlapping 2". Hold it against the rope so that one end projects a little beyond the rope end. Wrap the side of the loop which extends beyond the rope back around the rope. When the loop has diminished, hold as shown and pull on the projecting end of twine. Then cut off the loose ends.—WILLIAM H. DAVIS.

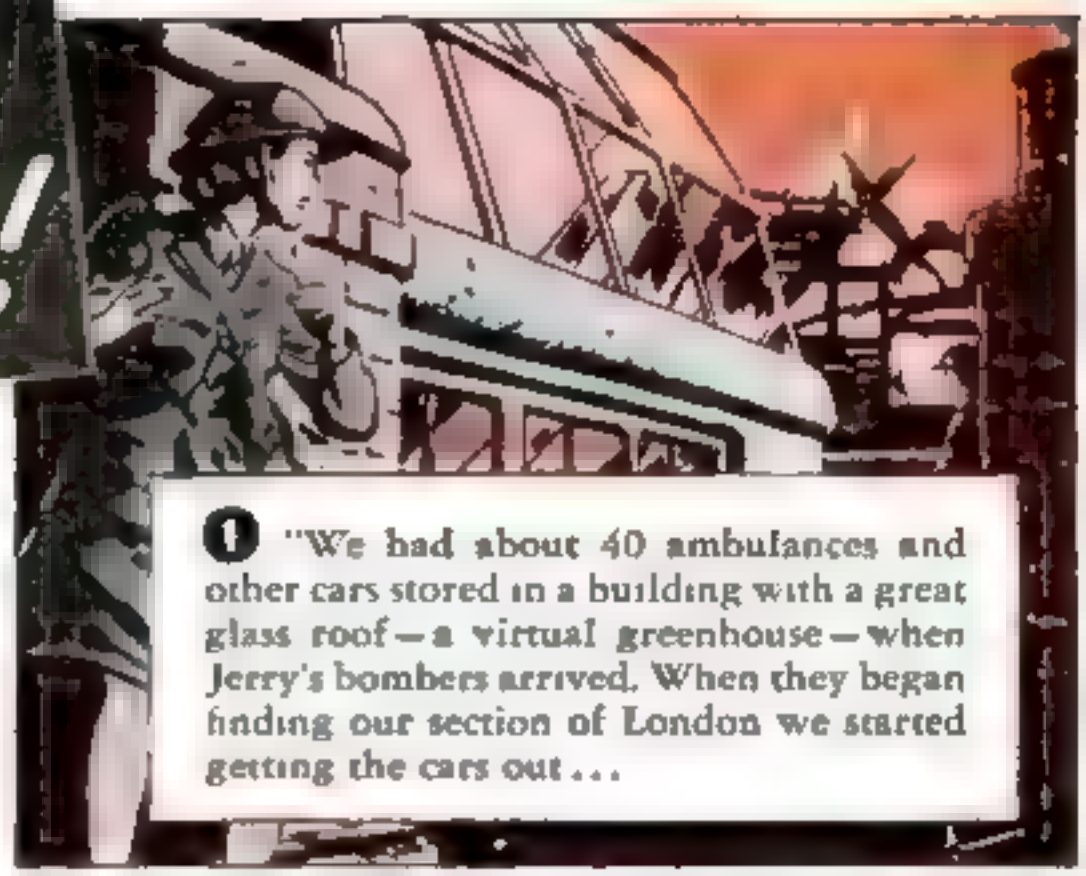


Perky Halloween Hobgoblins Are Created from Black Walnuts

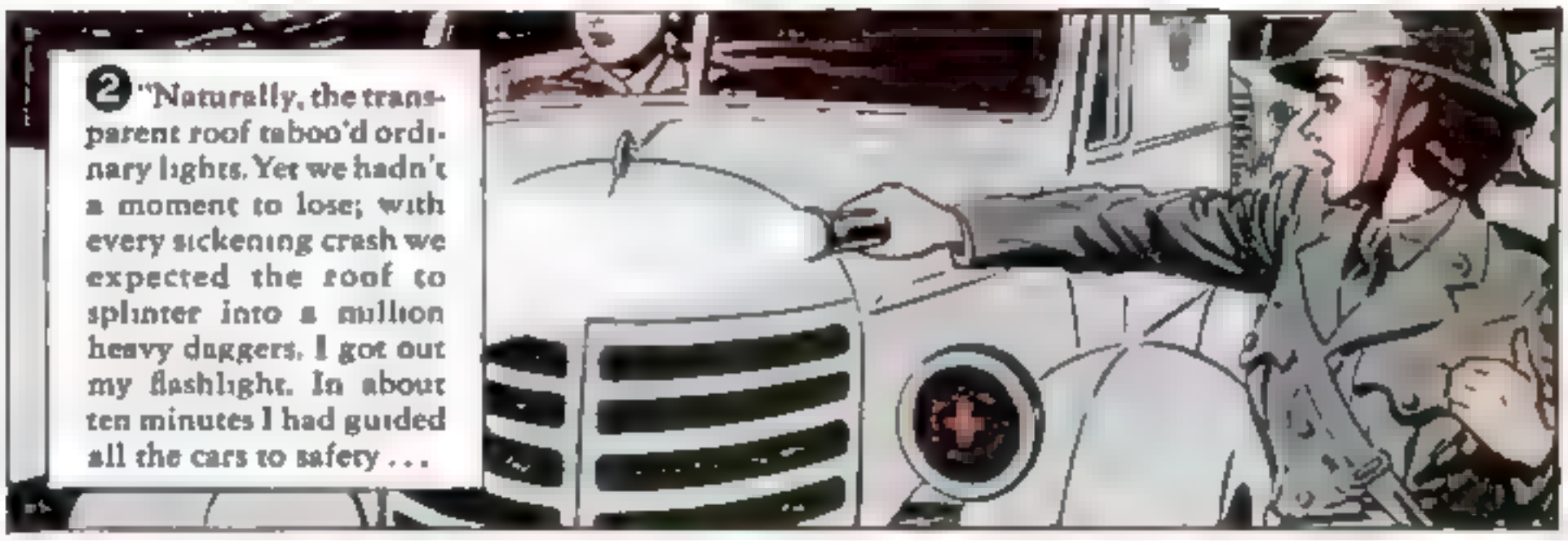
CAPTIVATING little hobgoblins for Halloween decorations may be made from a few black walnuts and pipe cleaners. Cut off a portion of the tapered end of the walnut so that you may use the exposed cross section for the face. The simplest way to do this is to hold the nut in a vise and cut it with a coping saw. Dig the meat from the two natural eye holes and fill the cavities with wood putty. After the putty has hardened, paint a little pupil on a part of each eye. The natural formation of a black walnut will give the illusion of a nose and mouth. Saw out the hobgoblin's big feet from ½" stock and drill holes in the head, body, and feet. Attach the head and feet to the body with pipe cleaners and glue, allowing the glue to set before painting all but the face with mahogany oil stain. The little fellows will serve to hold nut cups and place cards if their pipe-cleaner arms are bent properly. They may also be placed around the room as Halloween decorations.—E. W.

BLITZED IN A GREENHOUSE!

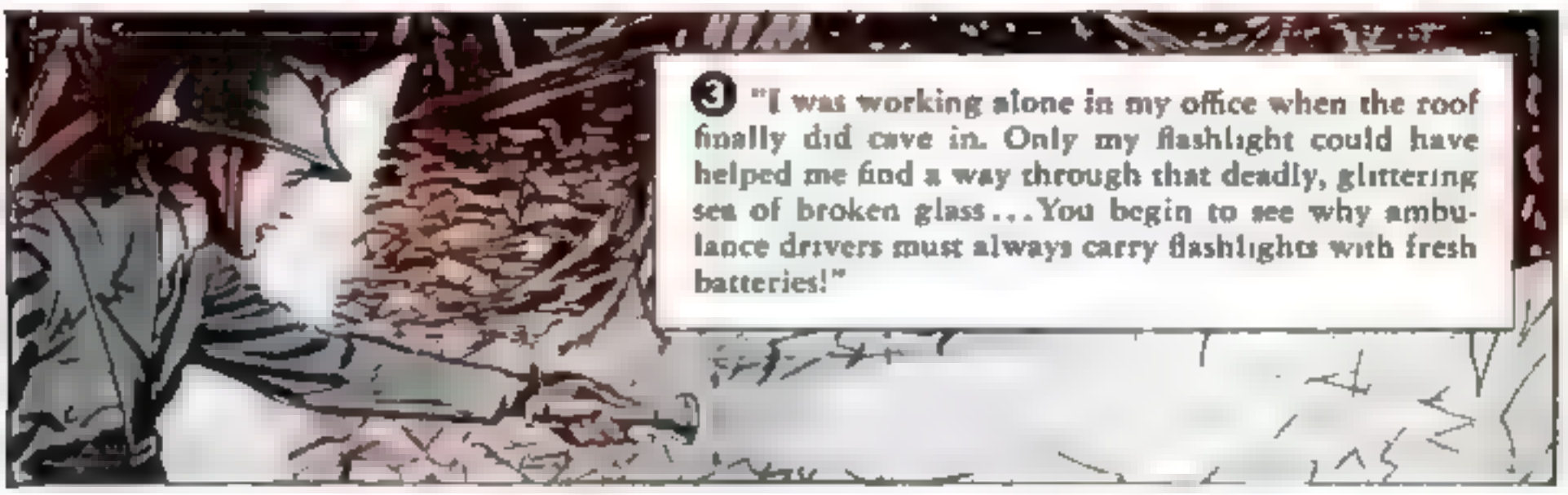
(The exciting experience of Margaret Bridges, of the London Auxiliary Ambulance service, during one of London's heaviest raids. Pretty, attractive 30-year-old Miss Bridges is part English, part American. She volunteered for the ambulance service, reporting for duty just three days before war was declared.)



❶ "We had about 40 ambulances and other cars stored in a building with a great glass roof—a virtual greenhouse—when Jerry's bombers arrived. When they began finding our section of London we started getting the cars out . . .



❷ "Naturally, the transparent roof taboo'd ordinary lights. Yet we hadn't a moment to lose; with every sickening crash we expected the roof to splinter into a million heavy daggers. I got out my flashlight. In about ten minutes I had guided all the cars to safety . . .



❸ "I was working alone in my office when the roof finally did cave in. Only my flashlight could have helped me find a way through that deadly, glittering sea of broken glass . . . You begin to see why ambulance drivers must always carry flashlights with fresh batteries!"

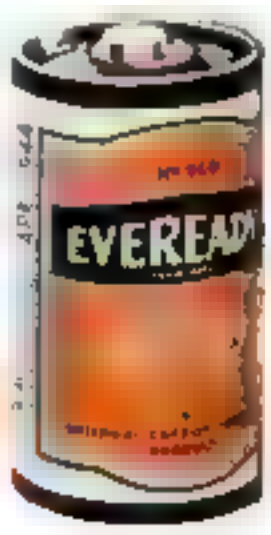
Your dealer may have no "Eveready" flashlight batteries. If so, please don't blame him—almost the entire supply is currently going to the armed forces and those war industries with the highest priority ratings.

Send for "You and the War," official O.C.D. guidebook to all vitally important war posts available to civilians. This free booklet tells exactly what there is to do and how to do it. Write National Carbon Company, Dept. D.P. 30 E. 42nd St., New York 17, N. Y.

NATIONAL CARBON COMPANY, INC.
30 East 42nd Street, New York
Unit of Union Carbide and Carbon Corporation

UCC

The word "Eveready" is a registered trademark of National Carbon Company, Inc.



Buy War Saving Bonds and Stamps regularly.

HW 573

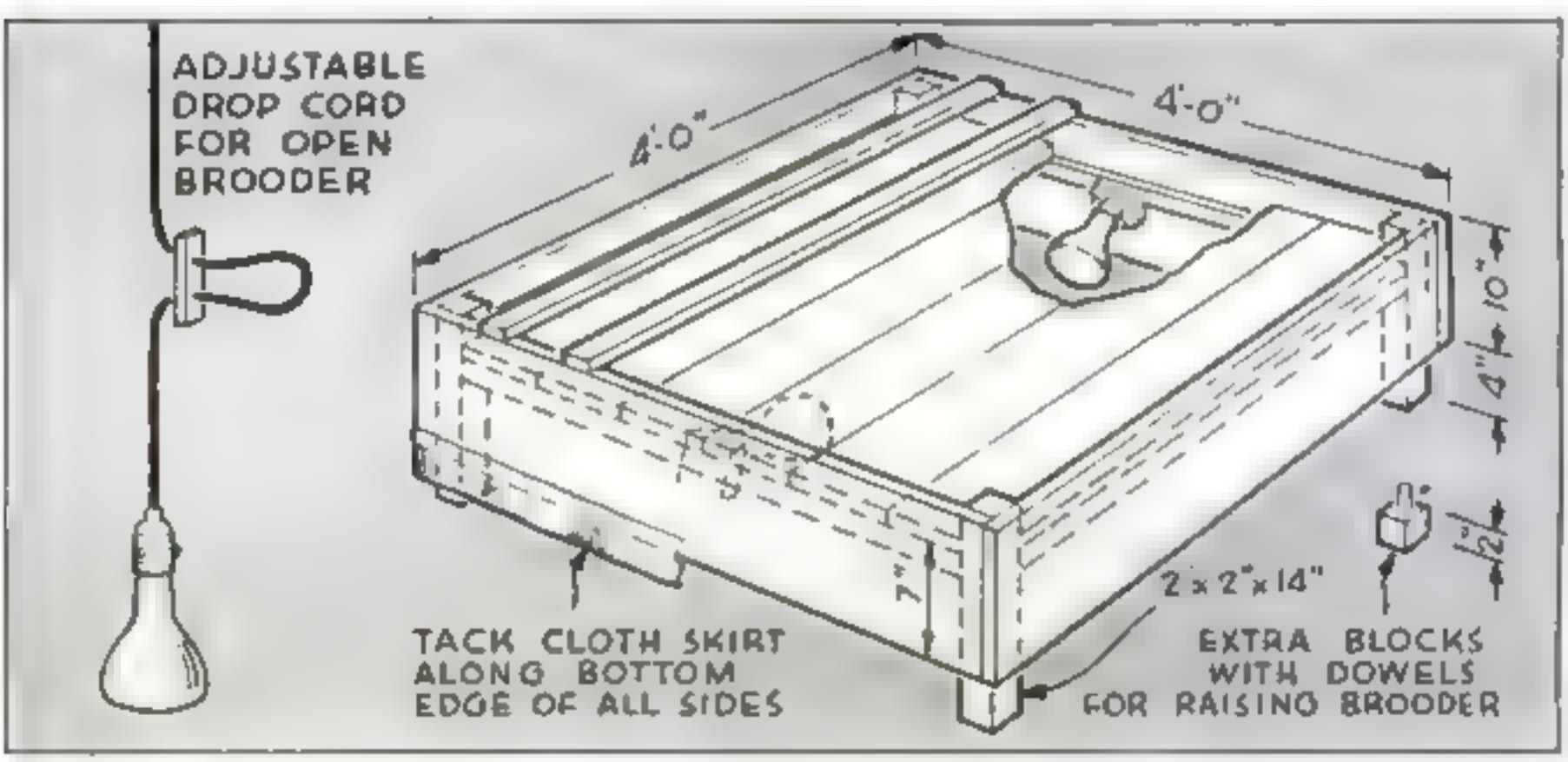
Homemade Brooder Uses Infrared Lamps as Source of Heat

WITH factory-made brooders hard to get, poultrymen may need homemade equipment to increase chick production. Shown below is a simply built brooder of 250-chick capacity which will let you raise "spring" broilers at any season, and which costs only $3 to $7 for materials. It was designed by Professor John E. Nichols, of Pennsylvania State College.

The brooder is made of ⅞" by 10" stock, with legs 2" by 2" by 14". Set the inside cleats 11" from the ground, and nail on them a flooring of 10" stock, 4' long. You will then have two shallow compartments, the lower one giving about 4" ground clearance. Fill the upper compartment with floor litter to serve as insulation, and tack a cloth skirt to the sides. Slats can be nailed across the top so that the brooder may later serve as a roost for older chickens.

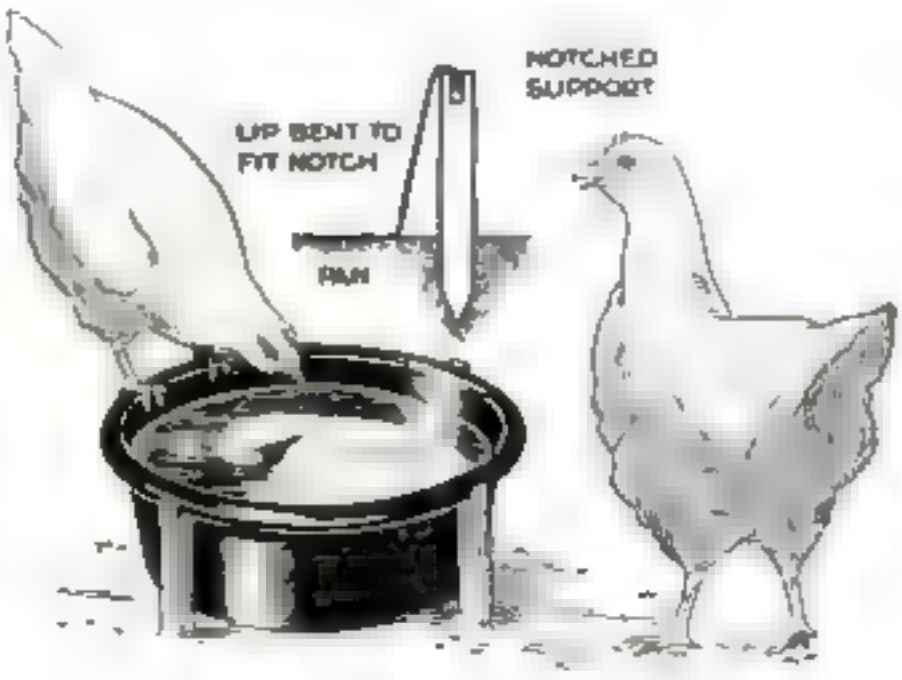
On facing inner sides of the lower compartment set two porcelain lamp sockets, and bore a ⅜" hole for the cord. A strip of wood under the upper edge of each socket base will give the lamps a desirable downward tilt. Be sure to use heavy-duty wire in connecting the sockets. The lamps are 150-watt reflector-flood types or 250-watt reflector-drying types, with rated lives of 1,000 and 5,000 hours respectively. These lamps, which project infrared heat rays as well as light, are especially suitable, although ordinary incandescent bulbs can be used if reflector types are unavailable. A thermostat is not needed with the former, since the chicks can find the right heat for their needs, but is desirable with ordinary bulbs.

An even simpler brooder for 200 chicks or less can be built by forming an uncovered enclosure of wood or light sheet metal and suspending one or two reflector bulbs over the area. Start with a lamp about 12" above the brood and raise it with the handy wire shortener as the chicks grow.



Wood Supports Keep Chickens from Upsetting Water Pan

CHICKENS perching on the side of a water pan will frequently upset it, particularly when the water level is low. A simple and practical method of preventing this is to use three notched supports as shown in the drawing to the right. Saw kerfs in the tops of three wooden stakes, sharpen the opposite ends, and drive them into the ground in the proper position. It may be necessary to bend the lip of the pan somewhat so that it fits the notches snugly.—JOHN K. KARLOVIC.



HW 574

BRILLIANCE WITH A PURPOSE

Like mirrors and jewels is the sparkle of polished metal parts in an Allison—but the eye cannot begin to see the perfection this brilliance reflects. ★ For one of the challenges in making aircraft engines is this . . . ★ To preserve — by exquisite accuracy of manufacture and finish — all of the inherent strength and endurance in every ounce of material used. ★ This need for perfection is nothing new to Allison. For years it has been our special province to handle metals with precision and lapidarian skill. ★ In today's tasks we are advantaged by all that General Motors has to offer in production techniques. ★ The result is a liquid-cooled aircraft engine which in performance can speak for itself—and an engine which we are resolved to make the finest in the world.

KEEP AMERICA STRONG
BUY MORE BONDS

POWERED BY
ALLISON

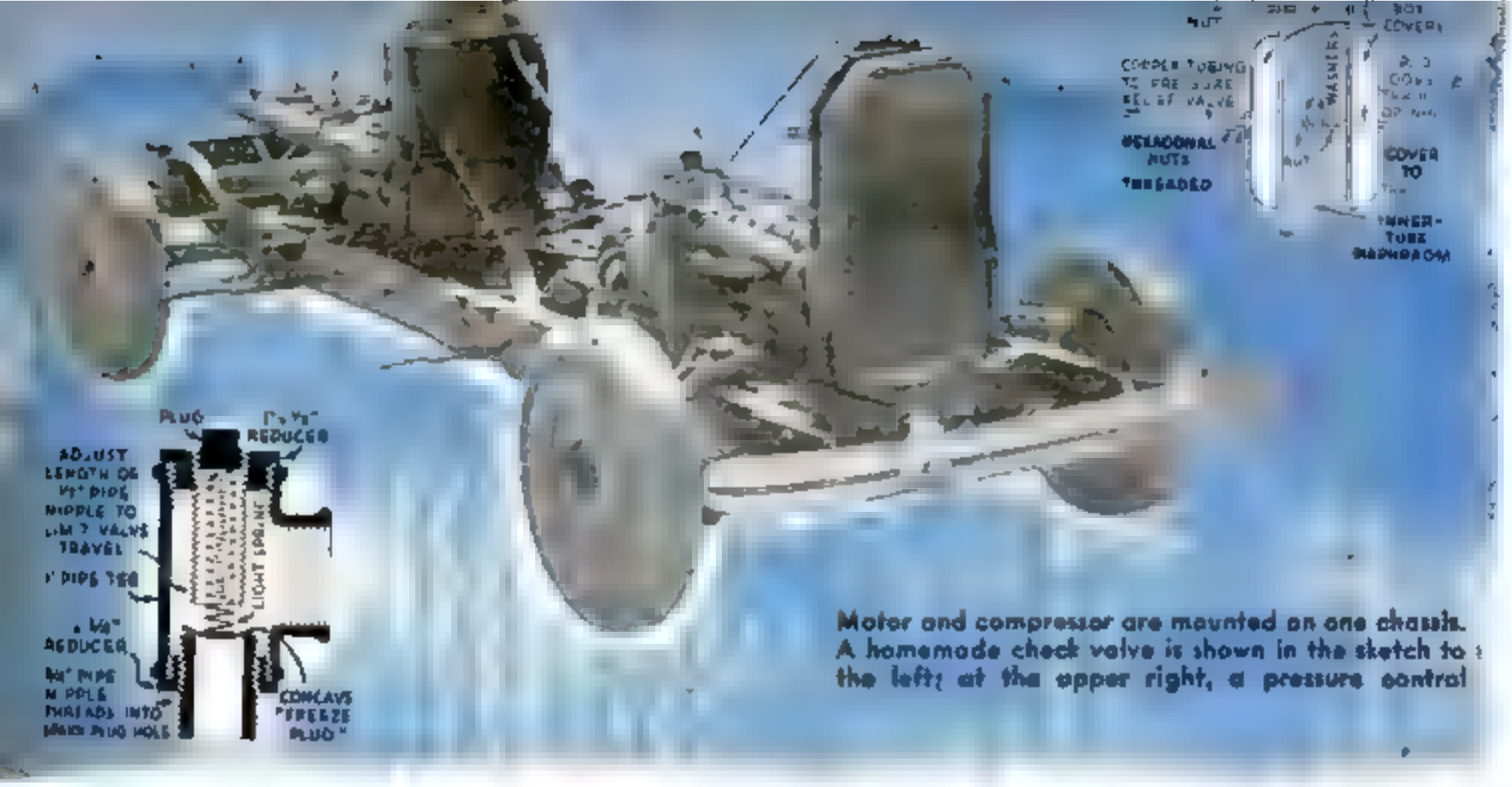
P-38—Lightning
P-39—Airacobra
P-40—Warhawk
P-51—Mustang

Allison

DIVISION OF GM GENERAL MOTORS

Buy War Saving Bonds and Stamps regularly.

HW 575

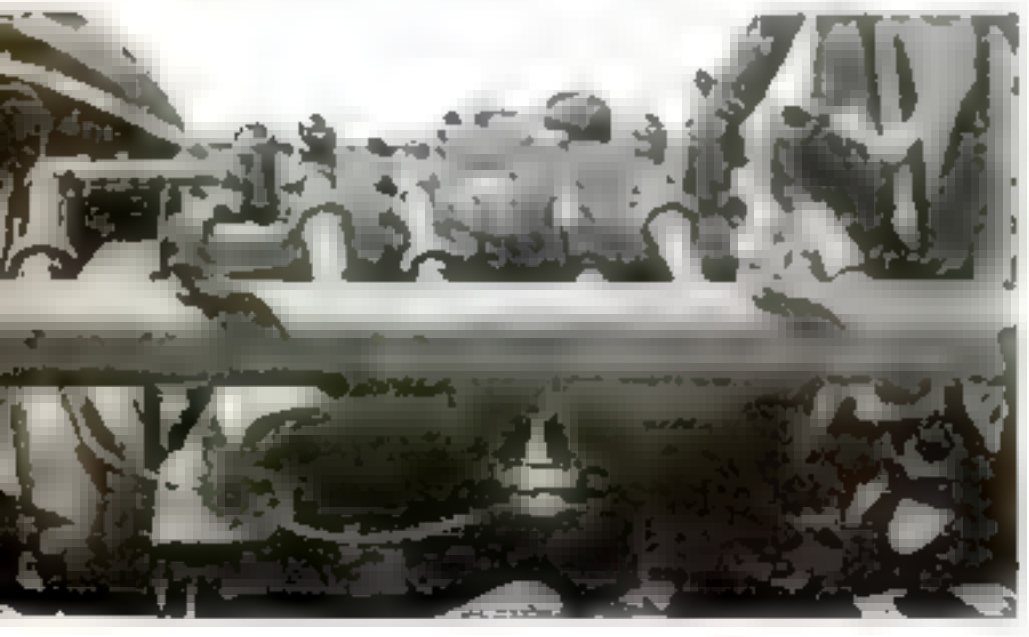


Motor and compressor are mounted on one chassis. A homemade check valve is shown in the sketch to the left; at the upper right, a pressure control

HEAVY-DUTY AIR COMPRESSOR

The throttle of this motor is controlled by a rod from a pressure unit that was made by bolting together two conduit boxes over a rubber diaphragm

On the compressor, below, the throttle control rod is moved by a vacuum overdrive unit, but the type used with the engine would have been satisfactory. The radiator is needed to keep the compressor cool



AIR compressors can't be bought readily today, so when a mining company needed one, Henry Lawrence, of Santa Fe, N. M., built it from two wrecked cars. A motor from one is used to drive a compressor made from the other motor.

To convert the motor to a compressor, Lawrence removed the valve lifters and installed light springs on the valves. This enables both the intake and exhaust valves to feed air to the cylinders, and makes each upward stroke a compression stroke. To filter all the air through the carburetor air cleaner, the exhaust manifold was closed off and an inner wall broken through to the intake manifold.

Studs were screwed into the firing chambers in the cylinder head and lead was poured around them to increase compression. Homemade check valves were screwed into the spark-plug holes. Each was made of a pipe tee, the valve proper consisting of a concave expansion plug such as is used to safeguard engine blocks against freezing. A check valve in the air manifold also keeps air from feeding back.

Two homemade control units govern the machine. The air chambers in the control units are connected with a hot-water tank relief valve set on the air tank. When pressure reaches the point for which this valve is set, the control diaphragms move rods attached to each carburetor. This reduces the engine speed to idling and also cuts off the compressor air intake so that it "coasts." A pinhole in the air line to the control units allows the pressure to bleed out slowly. Then both throttles open and pumping continues.—EUGENE S. HARRIS.

"FIRE BOMBS FALLING ...Rush the Pumpers!"

It's a forward base for the big push . . and the Japs know it. They're trying to burn us out. For a while it seems we have more fires than we can handle . . that is, till the fire pumpers arrive. They're hauled by anything that will pull! They unlimber and go into action like artillery. Fire just hasn't a chance with them around!

• • •

Nearly anybody can operate a Chrysler War Emergency Fire Pumper . . Originally developed to meet an acute shortage of fire equipment in areas vulnerable to air raids, they *had* to be simple and easy to use. Thousands of them now augment our regular fire departments in all parts of the country. They've proved so compact and mobile that many more have been sent into service at our advanced bases overseas.

The Fire Pumper is built around the same sturdy, dependable engine used to power thousands of cars manufactured by Chrysler. The engine with its moving parts Superfinished mirror-smooth — some to one-millionth of an inch, for quietness, economy and longer life.

Such Chrysler wartime developments demonstrate the pioneering leadership of Chrysler Division.

BACK THE ATTACK— WITH WAR BONDS

CHRYSLER

DIVISION OF CHRYSLER CORPORATION

WAR PRODUCTS OF CHRYSLER DIVISION

Industrial Engines • Marine Engines • Marine Tractors • Navy Pontoons • Harbor Tugs • Anti-Aircraft Cannon Parts • Tank Engine Assemblies • Airplane Wing Panels • Tank Parts • Fire Fighting Equipment • Air Field Sirens • Gun Bases • Navy Searchlight Reflectors.

THE NATION WIDE CHRYSLER DEALER ORGANIZATION OFFERS OWNERS SERVICE FACILITIES TO MEET THEIR WARTIME TRANSPORTATION NEEDS

New Theory of Air Power

(Continued from page 52)

equipment. An Air Support Party—sometimes a single liaison officer—is attached to a field unit, such as a regimental combat team.

These men funnel the inflowing mass of information, strain out what is important, pass on what the ground commander should know, and expedite requests for air support at specific places and times. Their work must be cool, unhurried, yet rapid and precise. The plans they draw up and the orders they give tell the story.

The complexity of air support, the fluid brilliance with which it functions in battle, is almost impossible to visualize without seeing it in action—and few civilians ever can have the chance to see it. Even the war correspondents who get behind the scenes of military operations are barred by security regulations from describing the technical workings of the machine.

To give a clear, dramatic picture of air support, POPULAR SCIENCE, with the cooperation of Army Intelligence sources, has arranged an account of one day's air-ground operations on a divisional front. It is accurate in every detail, although the description is sufficiently generalized that no information can be revealed to the enemy.

The opposing forces are facing each other along a line lying roughly between the town of X and Unknown River. Our forces are attacking to the north, while the enemy, giving ground slowly, is attempting to hold south of the river. At dark our troops have been stalled by stubborn resistance. The division commander has decided that he must lean heavily on air support in the next day's fighting.

The battle plan is set up at a conference in the tent of the chief of staff. Attack is to be resumed in the morning, with Combat Team X making the main effort on the left. Team Y will hold the right flank and Team Z will be held in reserve. The first need is for thorough air reconnaissance far behind the enemy line. The second is for heavy air support, as most of the artillery will have to be concentrated on a relatively narrow front in support of Combat Team X.

Air Commander recommends continued pressure to keep the enemy air force pinned down, plus a heavy bombardment of key rail lines. As for the direct support of the attack, that is a matter of careful timing. The infantry push is scheduled for 0615, preceded by a 10-minute artillery barrage of maximum violence, beginning at 0600.

(Continued on page 204)

You may worry about feeding your pets

but you won't worry about your car with Marfak Chassis Lubrication

With Marfak Lubrication you have a sweeter, smoother-running car. For Marfak, you see, is one of the finest, most thorough and efficient chassis lubrication services ever devised.

Your dealer works with a scientific Marfak chart. He checks every vital point on your car, from battery and tires to differential and rear-end gears. No guesswork here—the job is *accurate*, to protect irreplaceable engine and chassis parts.

Insist on genuine Marfak Lubrication today—to keep your car in "top" condition. At Texaco and other good dealers everywhere.

TEXACO

Let us MARFAK your car

CHASSIS LUBRICATION SERVICE

Tune in the TEXACO STAR THEATRE every Sunda... night. See your local newspaper for time and station.

You're Welcome at **TEXACO DEALERS**

New Theory of Air Power

(Continued from page 202)

Air support is to strike at precisely the interval, hitting at 0610 with a low-level attack by six A-36 Mustang fighter-bombers. Two minutes later the pounding will be taken up by another flight of six A-24 dive bombers.

As an indication of the precision with which air and ground operations are integrated, the artillery barrage will end with the firing of smoke shells to mark the objective for the diving planes; the last dive bomber gives the infantry the signal to go ahead by waggling its wings. Our own front lines will be marked with colored smoke to obviate any danger of an error in bombing objectives.

The chief of staff okays these arrangements and orders the necessary reconnaissance and photographic air missions to be worked out with the G-2 (intelligence) officer. Next comes a conference in the Air Support Control office, usually located near the divisional command post. The G-3 (operations) officer explains the plans for ground operations, while the Air Commander outlines his operations to the liaison officers of the various air groups — reconnaissance, dive bombers, medium bombers, and fighter planes.

The complex process of mounting a coordinated air-ground operation moves along as the air support and divisional signal officers go into a huddle of their own, check over their wire and radio communications, shift some of the radio frequency bands which are jamming up against powerful enemy transmitters, and arrange a code of visual smoke and panel signals. Finally, the Air Commander is ready to issue his attack and operations orders, which are teletyped to the airdromes over the A-2 wire net.

At dawn the attack begins, with a thundering artillery barrage pouring down on the hill which is the enemy's chief point of resistance. With split-second timing, at 0610, the artillery fires its smoke shells, the infantrymen set off red smoke to mark our advanced lines, and out of the low-hanging mists roar the A-36 Mustangs, to strike with their bombs, then vanish. Immediately the Douglas Dauntless A-24 dive bombers arrive, peel off one by one, and smash at the target. As the last plane gives the signal by rocking its wings, the infantry attack is launched.

While the ground fighting grows in intensity, the planned air operations go ahead with attacks on enemy air fields and supply

(Continued on page 208)

There's been a big change

● **Sentiment about the old things is an admirable American trait. But even the most sentimental of us must admit that change frequently is for the best.**

An outstanding example of progressive, beneficial change is that which Tyson has made in tapered roller bearings. Tyson improved the old-time conventional bearing by adding an average of 30% *more load-carrying rollers.* Result: Tyson users enjoy greatly increased load capacity—almost doubled bearing life!

* * *

These users often tell us that the Tyson "All-Rolls" Bearing is the greatest improvement in tapered roller bearings in forty years. *The big name in bearings today is*—TYSON!

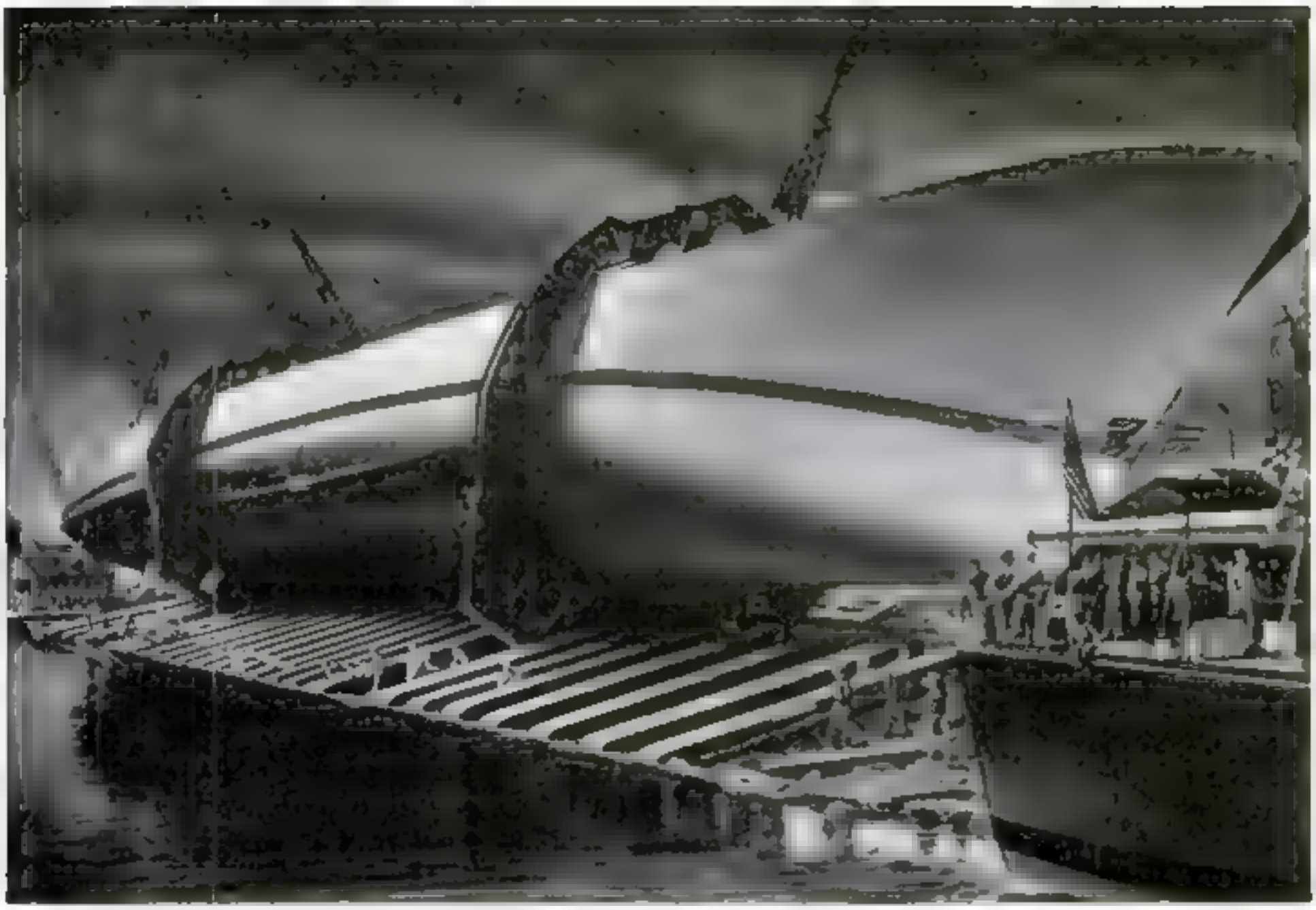
TYSON BEARING CORPORATION, MASSILLON, OHIO

COUNT THE ROLLS · THE ROLLS COUNT

Tyson

TODAY'S HEAVY-DUTY BEARING

★ BACK THE ATTACK — WITH WAR BONDS ★



750 Ton Flapjack!

HISTORY was made when the destroyer escort, U.S.S. *Bunch*, was "rolled over" successfully at the Defoe Shipbuilding yards at Bay City, Michigan. For this was the first time a steel-welded ship more than 300 feet long and weighing over 700 tons had been built upside down.

The same engineering feat that made it possible to build the U.S.S. *Bunch* in record time is producing an ever increasing fleet of sister ships—many of which are already in service with the Navy on the high seas.

Defoe's unique "flapjack trick" with ocean-going warships does away with conventional ship scaffolding and allows workers to stand over their job at all times. Defoe construction methods deliver *twice the production per man hour* resulting in *double the number of ships* built at *half the labor cost per vessel.*

Resourcefulness in developing new methods and shortcuts to speed delivery of ships to the Navy is typical of Defoe engineering tradition. And when our fighting men and their allies have dealt a knockout to the Axis, the same competitive spirit, skilled workmanship and "know how" that are now setting records in producing for Victory, will be reflected in even greater values of Defoe products to serve peacetime America.

"Next to our immediate task of building warships faster and faster, the first responsibility of Defoe is to plan for post-war operation that will provide the maximum of gainful employment."

HARRY J. DEFOE
Founder Defoe Shipbuilding Co.

★ ★ ★

BACK THE ATTACK—BUY WAR BONDS
Defoe workers take more than 10% of their pay in War Bonds

DEFOE SHIPBUILDING COMPANY, BAY CITY, MICHIGAN

Two White Star Renewal Citations now decorate the Navy "E" Award won by Defoe workers.

Defoe

Ships for Victory
Servants for Peace

New Theory of Air Power

(Continued from page 204)

lines. About 10 a.m. full reconnaissance reports and air photographs from 30,000 feet reveal an alarming development. A heavy enemy striking force, including 100 tanks and additional armored and supply vehicles, is moving up on the rear roads, clearly heading for the point of our main attack.

Meanwhile the infantry advance has run into terrific opposition at the contested hill, and has been stopped dead in the woods at the foot of the slope by heavy fire from mortars, machine guns, and 77-mm. field guns. The infantry commander has learned that he cannot get any additional artillery support, and has sent a hurry call for help to his accompanying Air Support Party officer, who radios Air Control to ask what missions might be assigned or diverted to help pull the situation out.

Here air command has two new and pressing problems. The enemy-held hill needs our attention; so do the approaching tanks. But ground-force headquarters must determine the relative priorities involved, and the division chief of staff unhesitatingly puts the tank column first. A reserve squadron of B-25's (North American Mitchell medium bombers) is ready, and is ordered into action through the flexible system of control.

Photo maps and latest reconnaissance data are hastily assembled, and the crews file into their field headquarters for briefing—an informal but deadly serious process. The youthful squadron leader explains casually that "our doughfoots are in a jam, and it's up to us to deliver a low-level attack that will stop a column of enemy tanks. They're getting too close to a spot that's already too hot."

He shows them the map point where they will take formation, echeloned to the right. The attack will be pressed home at extreme low altitude, with intervals of 2,000 feet. "Give 'em your forward guns on the way in, and release all bombs in train." Fighter escort is arranged with a near-by field. The combat crews pile into jeeps and trucks and roll out to their planes, scattered around the dispersal area.

The tank column, rolling south at 20 miles an hour, is attacked at "zero-plus altitude." The first B-25 sweeps in over the trees, its guns blazing, and cuts loose with its bombs, which have delayed-action fuses set for the planned attacking interval so that they will explode just after the plane is out of the way and before the next attacker slashes by.

(Continued on page 210)

Without batteries...war machines are useless!

1. Bomber 2. Destroyer 3. Submarine 4. Landing Barges 5. Troop Transport Trucks 6. Supply Trucks
7. Self-propelled 155 mm. Gun 8. Tanks 9 Jeep 10. "Walkie-talkie" communications

EXIDE BATTERIES ARE USED IN MORE THAN 100 APPLICATIONS BY OUR ARMED FORCES

Modern mechanized warfare demands a dependable source of electric power, which, under most conditions, only a storage battery can supply. Without such a source of power, our mightiest weapons would be useless, idle, dead.

Supplying dependable storage batteries to the armed forces is Exide's most important present day job, and you as a civilian motorist can help us provide America's fighters with more and more of them. You can do this by giving your present battery the very best of care. Let your Exide Dealer check your battery every two weeks. Trust him, and his dependable Exide Sure-Start Service, to prolong its useful life.

Remember, when you take care of things you own, you're really making important savings. Invest your savings in War Bonds.

Back the attack—with War Bonds!

Exide
BATTERIES

WHEN IT'S AN EXIDE YOU START

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia • Exide Batteries of Canada, Limited, Toronto

New Theory of Air Power

(Continued from page 208)

The formidable armored column disintegrates into a wild, scrambling mass of vehicles and men. Within 10 minutes the road is strewn with burned and blackened equipment, and the pummeled remnants of the enemy force are withdrawing in total confusion.

Meanwhile, air support is working on the problem of the enemy hill. No other reserve flight is available, so bombers must be diverted from a planned operation to take up this emergency job. By means of radio equipment and a secret technique, the air support command "vectors" a squadron of bombers on their way to blast enemy railroad yards behind the battle, and steers them to the new target. They wing in, drop a blanket of destruction on the enemy strong points and artillery emplacements, and clear the way for the combat team to push ahead, carry its objective, and then drive on to the river crossing against steadily deteriorating resistance in the late after-

For air operations the day ends with the return of the planes and systematic interrogation of the crews to determine the results of their attacks. This is done at the air fields, where the airmen gather at the squadron intelligence officer's office, make themselves comfortable with coffee and cigarettes, and then answer the long routine of questions on what targets they hit, what effect the bombs had, what air opposition or ground fire they encountered, what the weather was like, and so on and on.

But the day ends only in the sense that this information is summarized and reported on to the higher command, which starts at once to plan the air support for the next operation—only a few hours away. This, in capsule form, is how air support works. And what it means to the ground forces was best summed up by the Allied field commander in Tunisia, General Sir Harold Alexander, in this message to the African Tactical Air Command:

"Without your support this drive would just not have been possible."

NOTICE TO SUBSCRIBERS

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

Harley-Davidsons are Really *Standing Up!*

On all war fronts, the men who ride and service Harley-Davidsons are learning what "dependable performance" really means. You can't beat tough war action for proving that Harley-Davidsons can "take it and dish it out."

One fighter wrote from (CENSORED): "We're in an ordnance maintenance outfit and I'm overhauling trucks, cars and small engines. Harley-Davidsons are really standing up. They get twice the mileage and abuse other vehicles get before they need attention. I intend to get a new 74-OHV Harley-Davidson when I get back to the good old U. S. A."

Hundreds of these letters continue to pour in—and the story is always the same. Put your fighting dollars in War Bonds — and join the riders who are going to own newer, better Harley-Davidsons after the war!

HARLEY-DAVIDSON MOTORCYCLES

HARLEY DAVIDSON MOTOR CO.
Dept. PS, Milwaukee 1, Wisconsin

Please send at once free copy of 24-page "Enthusiast" Magazine, filled with motorcycle action pictures and thrilling stories.

Name _____

Address _____

City _____ State _____

FREE!

SEND COUPON NOW

Props for Our Warplanes

(Continued from page 127)

charged engines. If the propeller were, however, able to vary its blade pitch gradually from zero-angle low pitch up to 90 degrees high pitch, it would be flexible enough to absorb the engine's full horsepower at all altitudes. The constant-speed propeller is such a type. The prop and engine act as checks and balances against each other under all conditions of flight.

For emergency operation in the case of multimotored airplanes, this business of changing blade pitch has been carried a step farther to permit the "feathering" of the prop. The blades are turned in their hub through highest pitch until they are edge-on into the wind. The propeller is, of course, useless for thrusting in this position, but feathering is an expedient for flying with one or more engines out of operation, either by design or accident. Four-engined transports frequently cruise on only two of their engines, but this would not be considered good flying practice if full-feathering propellers were not available. Should an engine go dead in an emergency, the prop is feathered into the wind immediately; the prop in this position acts as a brake on the dead engine. In normal operating pitch, the prop would be subjected to "pinwheeling," just as the toy pinwheel spins when held to the wind, and this might result in a damaged engine. All the feathered propeller does is create a drag. A windmilling prop, however, would create more than 20 times this drag. The feathered propeller adds about 1,500 feet to the service ceiling of a twin-engined Douglas C-47 cargo transport flying on one engine and makes the plane much easier to handle. Even a single-engined airplane is at an advantage when fitted with a feathering prop because, in emergency, the plane's gliding range is half again as great with this type as it would be with a windmilling, unfeathered prop.

Carrying the pitch angle beyond the 90-degree feathered position into reverse pitch was a logical step in propeller development made first by Curtiss-Wright. The reversible-pitch prop, which delivers a negative thrust, is extremely useful as an air brake. In some instances, it may be used to slow the landing run of planes, but its most practical application is found on multiengined flying boats. Maneuvering a flying boat in the water is, at best, a tricky operation. The reversible prop facilitates maneuvering in general and turning in particular. By reversing the two inboard propellers and

(Continued on page 216)

Grease is great for machines, but men hate to put it on their faces. That is why so many men are switching from ordinary brushless to the new Mennen Brushless Shave – it's a cream, not a grease! Get it in either jar or tube.

A Lift from the Front at Guadalcanal

FOR all its grimness, modern war is merciful to our wounded. The life-giving miracle of blood plasma*... the swift, efficient treatment behind the lines... plus speedy transport to finely-equipped base hospitals... result in an incredibly high proportion of recoveries among even desperately stricken men.

Speedy Transport! It may be by giant transport plane, by ambulance or nimble-footed Jeep... or at jungle fronts in the South Pacific, by outboard-driven small craft threading narrow rivers, saving priceless hours between front lines and the base.

Evinrudes are busy at innumerable tasks for the Army and Navy, Marine Corps and Coast Guard... driving swift assault boats ... propelling pontons, lighters, ferries... powering huge rubber rafts, wherries, small craft of every type. *After Victory* there will be peacetime Evinrudes worthy of the traditions of their fighting forebears!

EVINRUDE MOTORS, *Milwaukee, Wisconsin*
Evinrude Motors of Canada, Peterboro, Canada

EVINRUDE

OUTBOARD MOTORS

**A pint of your blood can save the life of a wounded soldier or sailor. The need is constant, pressing. Call your local Red Cross Chapter for an appointment.*

Props for Our Warplanes

(Continued from page 212)

leaving the outboard props in normal pitch, the pilot of a four-engined flying boat can "come about" in one-fourth the turning radius of a similar craft with conventional propellers.

Under the most favorable conditions, the prop is capable of translating 86 percent of the engine's horsepower into useful thrust, and props have a specific weight of between .22 and .38 pounds per horsepower. (There are only three or four aircraft engines in the world that are known to have a weight-horsepower ratio of less than one pound per horsepower.) It is because there is so little room for improvement that propeller engineers are burning up much midnight oil and energy in their quest for increased power-plant performance.

It has been mentioned that the adaptation of the laminar-flow airfoil section—which holds the stream of passing air close to the surface and cuts down turbulence and drag—to prop blades increased their efficiency, and that engineers have sought to increase the blade area to gain more thrust and absorb the output of higher-horsepower engines. The compressibility phenomenon of the shock wave makes the engineers hesitate to increase blade diameter. Bigger props could be used only if they were geared down to turn slowly enough that the tips would not reach the speed of sound. When an airfoil attempts to exceed this speed, the pressure wave created at its leading edge cannot move ahead of the airfoil. The compressibility cannot get out of the way of the wing or propeller and must be carried along with it, just as the bow wave of a steamer is cast upward instead of outward along the surface when high speed is attained. Unlike the much denser water, the air has nowhere to go and must be dragged along, coating the propeller with tightly packed, turbulent air that does nothing but create such drag that the airfoil loses much of its thrusting ability.

Hamilton Standard engineers increased their blade area without extending the diameter by making the blade paddle-shaped from the shank outward. The paddle blade is wider, with a more rounded tip, and is still structurally strong enough at the shank to withstand the many stresses. There is, however, a limit to the width of the blade. The ability to absorb the engine's power increases directly in proportion to the width of the blade, but, unfortunately, the weight increases with the square of the width.

(Continued on page 218)

Royalton

Royalton Silver Crown — *Choice Grains* — $5

It's "that little more" that brings success in life. So with pipes. A Royalton adds that extra something to make a good tobacco taste better. Because this greater satisfaction brings enduring pleasure, a knowing smoker and his Royalton are seldom parted.

WHEREVER BETTER PIPES ARE SOLD

Props for Our Warplanes

(Continued from page 216)

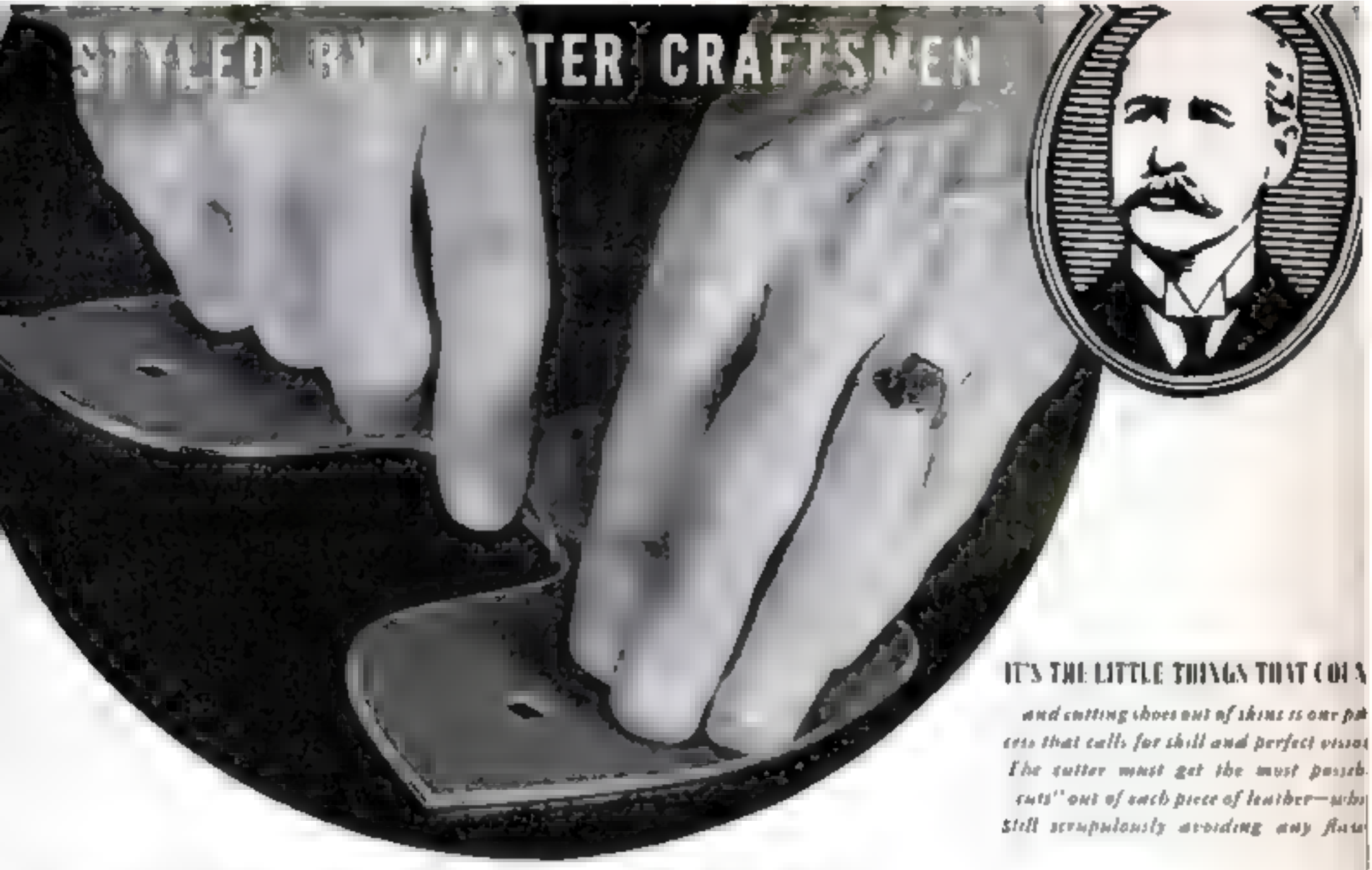
When the blade is made thicker, it displaces more air and builds up compressibility more readily.

There are still other more involved limitations. One of these was the problem of cooling the radial-type engines, since the slip stream, or backwash of air from the prop, is hollow in the middle because of the blades' shape. This was overcome by fitting the blades with cuffs that continue the airfoil shape right down to the hub. This additional surface provides larger thrust area and also brings the hole in the center of the slip stream down almost to nothing. Part of the backwash is then able to enter the engine cowl and contribute to cooling.

The next obvious step in gaining thrusting area was the use of more blades. When planes began to use the bigger engines, the demand for more than three blades forced engineers to solve the vibration problems introduced by four- and six-bladed props. Four-bladed propellers of wood were used in World War I, and were reintroduced by Curtiss in hollow steel form in 1939. Planes that use four-bladed props include the Martin Marauder, Republic Thunderbolt, North American Mustang, and Britain's Spitfire IX (with a British Rotol prop).

The ultimate in props today is the four- or six-bladed dual-rotation job, which consists of two units mounted on coaxial shafts which turn in opposite directions. Even these have been fitted with constant-speed, feathering hub mechanisms by Curtiss, Hamilton Standard, and General Motors, and by Rotol and De Havilland in Britain. They are, literally, two propellers and naturally are heavier than a single prop. But because they can be of smaller diameter and blade width, the weight is not actually doubled but is only about one third greater. The dual-rotation props are worth their weight in performance. First of all, they do away with the evils of torque, or swinging action in flight, since the torque of one set of blades cancels out that of the other unit. Shorter landing gears can be used because of the smaller blades, and this results in a great saving of weight and improved landing behavior of the plane. At speeds around 400 miles per hour, the contra prop increases aerodynamic efficiency more than five percent. The rear prop picks up the whirling slip stream of the forward set of blades and converts it into useful thrust.

The engineers are hard at work on still newer ideas, but the dual-rotation prop will be with us for many years to come.



IT'S THE LITTLE THINGS THAT COUN

and cutting shoes out of skins is one pa
ces that calls for skill and perfect vision
The cutter must get the most possib
cuts" out of each piece of leather—whi
still scrupulously avoiding any flaw

STYLED for GOOD LOOKS

at "Sure for War Bond Prices"

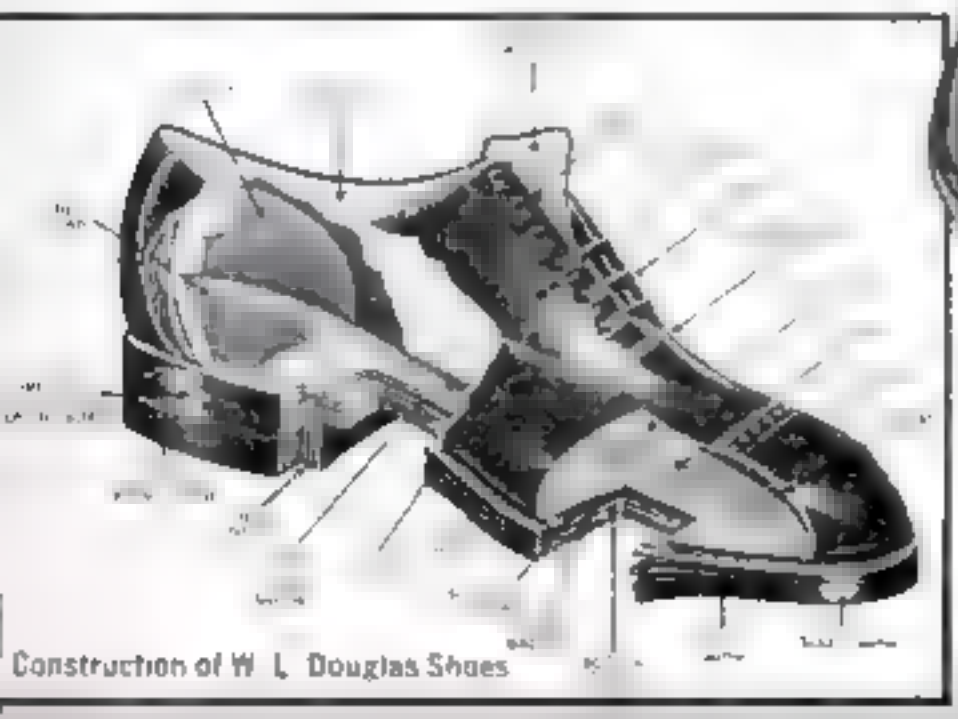
It takes 8 full days—and over 130 separate hand and machine operations—to make a single pair of W. L. Douglas Shoes. It takes accuracy and skill, too, and more patience than you'd think possible. For the experts who make W. L. Douglas Shoes take pride in perfect work—and they aren't satisfied with less.

That's why, today, men everywhere are buying W. L. Douglas Shoes with their ration coupons. That's why *you* should see our new Fall shoes today. They're styled for good looks . . . and priced for honest value.

W. L. Douglas Shoes

W. L. DOUGLAS SHOE CO., BROCKTON, MASS.

Stores in Principal Cities—Good Dealers Everywhere



Construction of W. L. Douglas Shoes

The Commander
A favorite of service men and civilians is this tan plain toe military oxford. Rugged leather sole for all-weather comfort. No. 4563. In Black, No. 4655

$6.50 $8.50
Other styles at $5.50

The Wingal
Handsome moccasin-type oxford in ro brown leath —with Dougl Flex soles fo longer wear greater comfort No. 4516

Doug as Down to the-l construction assures you belt

BUY WAR BONDS AND STAMPS FOR VICTORY

"Seeing" the Weather

(Continued from page 95)

Because of the help they might afford the enemy, official weather reports are out for the duration. But there's no reason why you can't learn to be your own weather man. Here are a few simple "hows":

If a summer sky has small cumulus clouds which don't tend to grow larger by noon, you can bank on clear weather.

If you see a bank of cumulus clouds that is growing and building up to a summit, look for rain, hail, and lightning.

If there is a cloud layer over the horizon, and it begins to form turretlike shapes at its top, you are in for squalls.

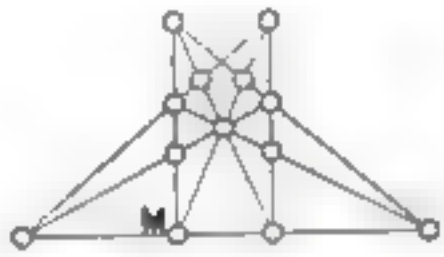
If you see high bands of clouds extending east and west and moving fast, it means that there is a cold snap on the way.

If clouds clot into thick masses and blot out the sun, duck for cover.

Brain-Teasers in Uniform

(Answers to problems on page 89)

1. His weekly pay is $99.98.
2. 295 bombs.
3. Here is one of the possible solutions:



4. Boat D enters P. Boats A, B, and C pass P.
   Boat D goes on its way. Boats A, B, and C return to the other side of P and same operation is repeated for E and for F.
5. The two hands are together at
   12:00 Noon
   1:05 1/11 A.M. and P.M.
   2:11 " " "
   3:16 1/11 " " "
   4:22 " " "
   5:27 3/11 " " "
   6:33 " " "
   7:38 " " "
   8:43 1/11 " " "
   9:49 " " "
   10:54 1/11 " " "
   12:00 Midnight
   134 sentries stand watch.
6. Outfit A, which receives $144. Outfit B receives only $72.
7. A man could; but a ship might not be able to. The wire would be about 16 feet above the surface of the earth.

"Maybe next year, Queenie!"

"Mallards! Gosh, don't they remind me of some swell times!

"Gets *you* kind of excited too, Queenie, doesn't it? I understand. My dog was a lot like you, and I know how he loved hunting.

"There'd be cold, gray autumn mornings when the wind almost blew our ears off. Just the right weather for ducks. I'd paddle us out to our favorite hunting place in the marsh. Pretty soon our wooden decoys would be bobbin' away, natural as life, and a big flight of mallards would start down to get chummy. Then—*kkammo!*

"No matter how far away the ducks dropped, that dog of mine used to retrieve 'em every time. I'll bet you did too. And boy, what wouldn't we both give to do some duck hunting this season!

"But there's a war on now, Queenie. We're in the Coast Guard, and we've got a job to do. Maybe *next* year . . ."

* * *

Remington's job right now is to supply a lot of military arms and ammunition fast—to help speed, among other things, the return of hunters and hunting dogs to their favorite marshes. Here is what we are doing . . .

1. ***Every working day,*** *Remington produces thirty million rounds of military small arms ammunition.*

2. ***And, every working day,*** *Remington produces more than enough military rifles to equip an entire infantry regiment at full fighting strength.*

After the war is won, we will again be serving our sportsmen friends with Remington shotguns and rifles, Nitro Express shells, Kleanbore Hi-Speed .22's, and Core-Lokt big game bullets. *Remington Arms Company, Inc., Bridgeport, Conn.*

"Nitro Express," "Kleanbore," "Hi-Speed," "Sportsman," Reg. U.S. Pat. Off. "Core-Lokt" are trade marks of Remington Arms Co., Inc.

HELP YOURSELF LATER BY HELPING YOUR COUNTRY NOW. BUY WAR BONDS!

Remington Sportsman 3-shot autoloading shotgun and Nitro Express shot shells

Remington

DUPONT

Send your soldier "Good Pictures".. . . of the old familiar scenes . . . the home place, the best girl, the old fishin' hole, sister Mary's new baby, the puppy now a dog, the cabin up the river . . . all the happy scenes of home sweet home. That's what counts a thousand miles from nowhere.

Make the most of your present camera! Take good care of it, and conserve vital film by making each picture a good picture. After Victory Argus will make new cameras . . . employing the new techniques and extensive experience acquired in War Production.

FINE AMERICAN CAMERAS
•
PRECISION OPTICAL INSTRUMENTS
•
AVIATION RADIO EQUIPMENT
•
BUY WAR BONDS

AWARDED TO PLANT 2
OF ARGUS DIVISION

"Good Pictures"

Make the best use of your present equipment — learn more about lenses — films, filters and composition. Send 25c today for this 56-page booklet

argus
INTERNATIONAL INDUSTRIES, INC.
ANN ARBOR MICHIGAN

Men with Mechanical Ability Needed in Vital Shipyards

Here's a chance for men who know how to use tools and operate machinery to get into a vital war job—just about the most important job a civilian can do. Thousands of men and women are needed *now*—to build and repair ships.

If you are not now engaged in war work, get a job in one of the repair or shipbuilding plants of the Todd Shipyards Corporation.

You will be well paid while you take a fighting crack at the enemy. Mail the coupon today and be sure to indicate the city in which you prefer to work. We will advise you of the proper U. S. Employment Service office through which you may discuss employment.

No placement fee. Persons in essential activities cannot be considered without statement of availability.

If inexperienced you are paid while learning.

"I'm in a shipyard to help get my two boys home safe. That's what we're working for—to help our fighting men finish the job fast. We need your help. How about clipping that coupon right now?" *C. L. ERICKSON, Todd Foreman*

Todd Shipyards are located in:

BROOKLYN, N. Y.	HOUSTON, TEXAS
HOBOKEN, N. J.	SEATTLE, WASH.
S. PORTLAND, MAINE	TACOMA, WASH.
GALVESTON, TEXAS	NEW ORLEANS, LA

Mail to
TODD SHIPYARDS CORP., Employment Dept
One Broadway, New York 4, N.Y.

My occupation is_____

Draft status_____

Also know_____

Prefer to work in (name of city)_____

Name_____

[illegible]_____

City_____ State_____

Todd Shipyards Corporation

ONE BROADWAY
NEW YORK

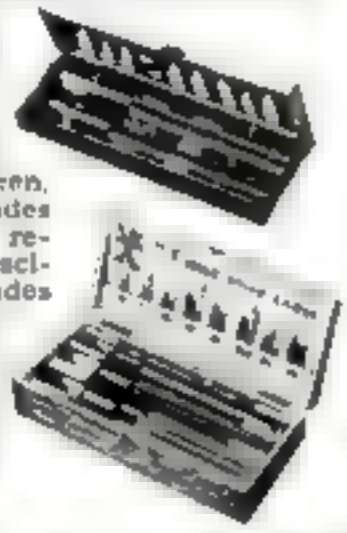
for more than a quarter of a century, builders and repairers of fighting ships for the U. S. Navy . . . merchant ships for all the world

Make Models with KEENER, safer, FASTER X-acto Knives!

You, too, will be an EXPERT modeler

The Navy—and the Army, too—need thousands of authentic scale models of allied and enemy planes for teaching quick identification. Use X-ACTO knives to speed up this production

Make Model Planes for Uncle Sam!



No other knife at any price has all the rich features that make X-ACTO the undisputed first choice of model makers. Its super-keen, surg cal-steel blades just re-blade to re-sharpen) and the scientifically shaped blades in eight styles, give the craftsman the most versatile tools of his whole outfit. With these amazing knives, you increase output and improve accuracy

Kit No. 82—Double set with 2 handles 12 blades and fitted wooden chest **$2.00**

Kit No. 83—Furnished with 3 handles 12 blades and fitted wooden chest **$3.50**

FREE with your order 32 page Manual "How To Build Model Planes"

X-ACTO Knife

RE-blade to RE-sharpen

At Your Hobby Dealer's, Hardware or Dept. Store

X Acto Crescent Products Co.
440-4th Avenue, New York 16, N. Y.
Send all more X Acto I have checked. It is understood if I am not satisfied I may return with in five days for refund. Also enclose FREE 32 page Manual "How To Build Model Planes"
☐ Enclosed find $ ____ in full payment. X Acto desired: ☐ Kit No. 82—$2.00 ☐ Kit No. 83—$3.50 ☐ No. 1 (light) with one handle size ☐ No. 61 with 3 extra assorted blades $1.00 ☐ No. 2 (heavy)—with one handle size ☐ No. 62—with 5 extra assorted blades $1.00
I will pay postman $ ____ plus postage on arrival. (NO C O D 'S ON 50c ORDERS) You can save postage and I'll pay by remitting with order

This Is The Wheel, Mr. Jones

Maybe you were stumped by grinding jobs before, but they won't worry you anymore.

300 shapes and sizes—every grade and grain—there is a Chicago Mounted Wheel custom-built to take on *any* grinding problem. Each wheel is a whirling point of power that turns your jobs out smooth—and in a hurry.

PROMPT DELIVERY—Our wartime set-up concentrates on mounted points and grinding wheels 3" in diameter and under. Production is stepped up and keeps pace with demand.

Handee Tool of 1001 Uses and **Mi-Power Grinders** are still available to all who have priorities.

Send for Free Catalog.

CHICAGO WHEEL & MFG. CO.
118 S. Aberdeen St. Chicago 7, Ill.

America's Fastest Selling Novelty Sensation!

Flippy

Military Strip Tease

CIGARETTE CASE

You ain't seen nuthin' 'till you "flip the cover"

Flippy is Daring . . . yet so clever it never offends. Everyone wants one on sight! Friends will clamor to learn where you got it.

SEND NO MONEY: Simply send your name and address on the post card for you. Flippy ships and pay postman $1.50 plus postage (or send $1.50 with order and we pay postage)

Special Offer—2 for $2.50

FLIPPY, Dept. P.S. 1, Box 3820
Mdse. Mart, Chicago

Unequated Gift Item for Every Smoker

Any smoker will get a bang out of Flippy. There's a flash show with every smoke. Flip cylinder ably in the trap pocket of slip lighter cover. Each case is moulded in smart color full plastic sparkle like a jewel

Wood workers: Here it is! Harold

only 10c

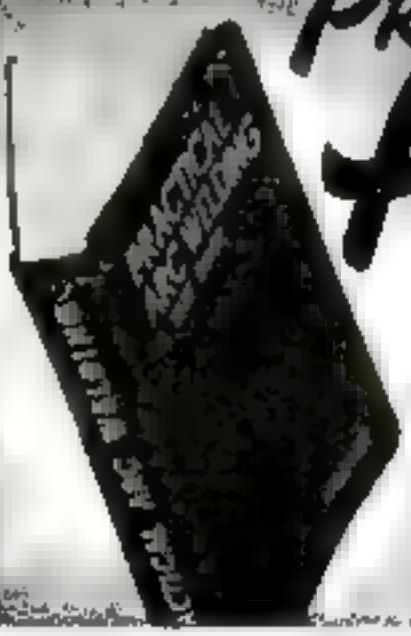
Hunt a big revised No. 4 Wood Catalog! Latest UP-TO-DATE IDEAS for experts and amateurs. SPECIAL BARGAINS in rare woods, veneers and ALL kinds of supplies. 24 pages, 12 of them in color. Get posted. Send only 10c at once.

CRAFTSMAN WOOD SERVICE CO.
2729 S. Mary St., Dpt. S-39, Chicago, Ill.

PRACTICAL ARC WELDING!

Newest Edition Complete Concise, Authoritative.

516 PAGES; 512 ILLUSTRATIONS, NEW techniques, procedures, methods, materials clearly explained. A text book and daily guide for operators on vital war work.



Here at last is a complete arc welding manual covering every phase of the subject for the beginner and past master alike. Every proper procedure is outlined, diagrams show you exactly how to proceed for the type of metal, position of welding and rods used. A big, full sized book full of valuable information that'll be worth hundreds to you.

Order your Copy NOW! **$2.00** Postpaid

or sent on **5 DAYS APPROVAL** *if you wish.*

Hobart Bros. Co., Box P-113, Troy, O.

192 page ARC WELDING Lessons Book

Used in Hobart's Famous School. Is a complete outline for a self-instruction or refresher course. Worth many times its low price

—Only 75¢

HOBART

"One of the World's Largest Builders of Electric Arc Welders."

HOW TO CHOOSE A GLUE

Don't think that there is any *one* glue that does all gluing jobs. Here are two simple rules to follow.

RULE 1 **USE CASEIN GLUE:** For all interior or protected construction—furniture, cabinets, toys, laminated trusses and beams, interior wall panels and all types of "odd jobs".

REASON: Casein Glue (CASCO) is easier, more foolproof to use than resin. CASCO is "self-bonding," needs only moderate, not extreme pressure. Has "filling action" on poorly fitted joints. Highly water-resistant, withstands any interior conditions except extreme dampness or mold. Used at any temperature (above freezing).

RULE 2 **USE RESIN GLUE:** Where a waterproof, moldproof or stainfree glue is required—boats, outdoor furniture, screens, in damp basements, on thin veneers, etc.

REASON: Resin Glue (CASCAMITE) is completely waterproof, moldproof, stainfree. (Resin glue requires well-fitted joints, smooth wood surfaces, positive clamp pressure and workroom temperature of at least 70°F.)

CASCO Powdered Casein Glue

Meets Army, Navy and Federal casein glue specifications. Highly water-resistant. Cold water mix. 10¢ to 65¢ at hardware stores.

CASCAMITE Powdered Resin Glue

The same type of glue used for Army and Navy life floats, truck bodies, other field equipment. Mixes instantly in cold water. 10¢ to 85¢ at hardware stores.

FREE GLUING GUIDE AND PROJECT BOOKLETS

CASEIN COMPANY OF AMERICA! Dept. PS-11
350 Madison Avenue, New York 17, N. Y.

Send me the literature checked.

- ☐ "GLUING GUIDE". Complete directions for both glues. Over 80 home workshop jobs.
- ☐ "CASCO PROJECTS". Describes 24 furniture projects by famous American designers. How to get free plans.
- ☐ "CASCAMITE WATER PROJECTS". Describes 12 new boat and water projects by Wm. F. Crosby. How to get free plans.

NAME .....

ADDRESS. .....

Save 2¢—Stick coupon on penny postcard

Buy War Savings Bonds and Stamps regularly.

FREE! LATEST, MOST COMPLETE RADIO PARTS CATALOG

EVERYTHING in RADIO and ELECTRONICS for War Training, Maintenance or Repair

It's the most complete, up-to-date BUYING GUIDE available! It contains latest "supply data" on radio and electronic parts available without priority for repair and replacement—*plus* everything in war training kits, books and equipment! Whatever you need—you'll save time by getting in touch with ALLIED *first*. Send for this big free catalog today.

RADIO'S FINEST BOOK VALUES

Specially prepared to aid radio training in schools and industry. Full of valuable data. Send for all six!

Radio Formulas and Data Book No. 37-752. 10c
Dictionary of Radio Terms No. 37-751. 10c
Radio Circuit Handbook No. 37-753. . 10c
Radio Builders' Handbook No. 37-750. . 10c
Simplified Radio Servicing No. 37-755. . 10c
Radio Data Handbook No. 37-754. . 25c
All Six Books No. 37-799. . 75c

ALLIED RADIO CORP.,
833 W. Jackson, Dept. 7-L-3, Chicago

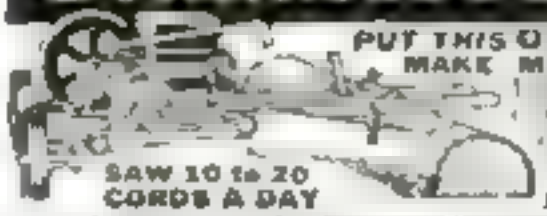
POWERFUL VISION — LONG RANGE

6-POWER TELESCOPE $2.49

Perfect for spotting ships, planes, watching sporting events, people, birds, etc. Genuine high life-time power 6 power achromatic 2-color coated 35 mm lens. Objects 600 yards away appear as 100 yds. distant. Simple to focus, no tools, sturdy, and extraordinary objects. 15 DAYS FREE TRIAL. If not fully satisfied, return for refund. SEND NO MONEY. Just pay postman $2.49 plus few cents postage on delivery. Cash and we send postpaid! Don't wait. Imitations of telescopes may be curtailed as it has been on binoculars.

Vegue Telescope Co., 7359 S. Halsted, Dept. B-408, Chicago.

OTTAWA LOG SAW **Write for FREE BOOK**

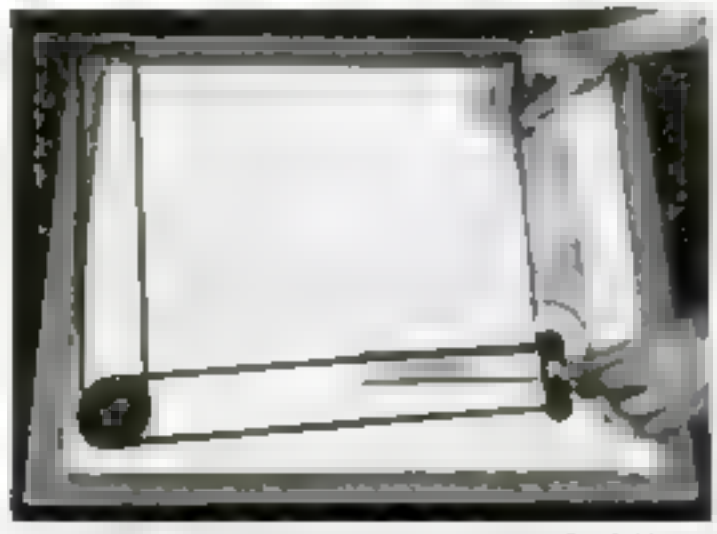


PUT THIS OTTAWA to work for you. MAKE MONEY! Wood is valuable. ... 10 men busily ... trees—and saws. Use 5-hp. engine for ... work.

SAW 10 to 20 CORDS A DAY

OTTAWA MFG. CO.
1101 Wood St. Ottawa, Kans.

MASTER DRAFTING MACHINE



● Biggest time saver for dimensioned sketches, lettering and layouts ever sold at—*This Low Price*—While they last. Limited Supply...only

$3.95

ORDER TODAY

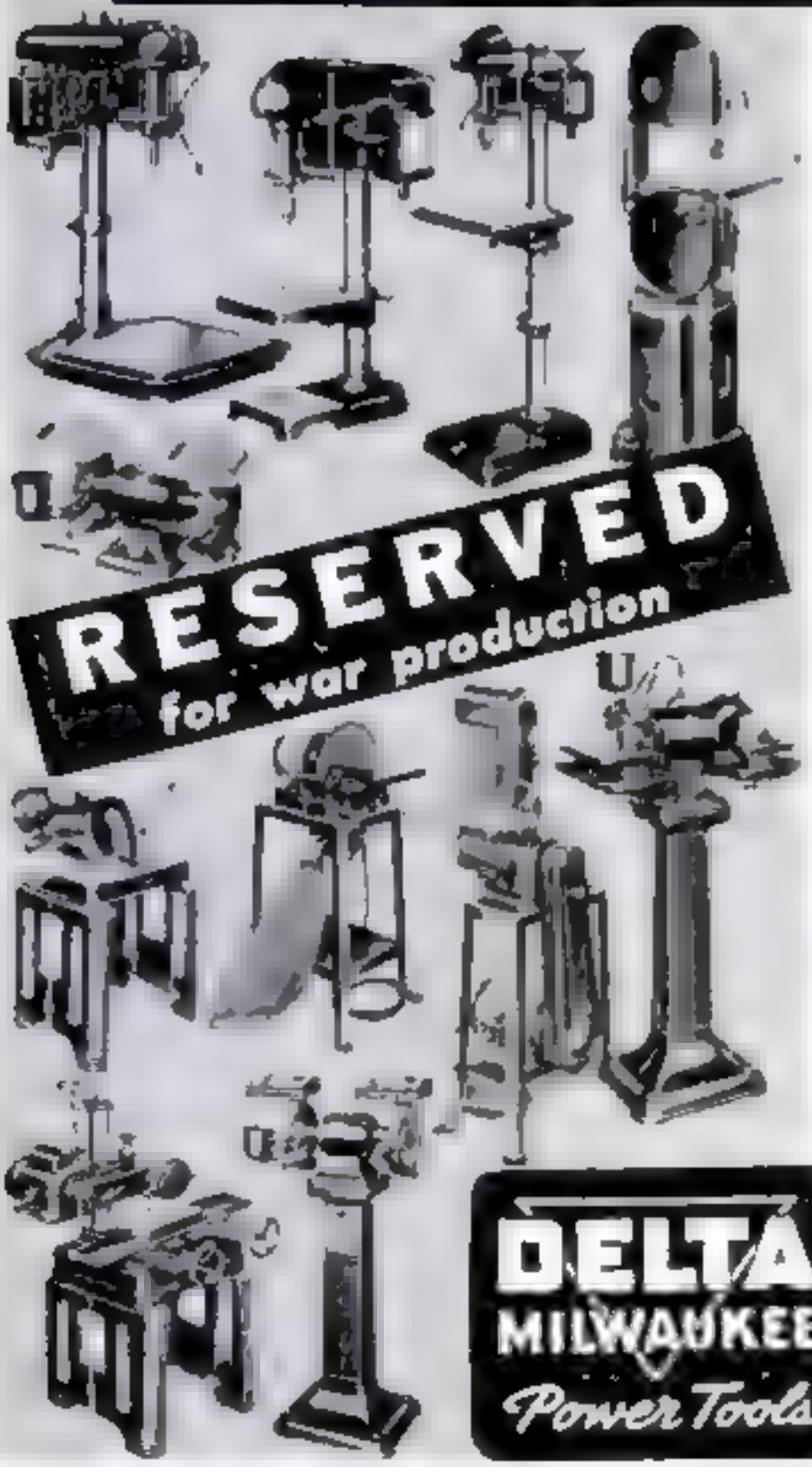
RANDOLPH RADIO 611 West Randolph St. CHICAGO-ILLINOIS

Here's how you can plan now for

More Fun and more Profit - with

DELTA POWER TOOLS

..in your after-the-war home workshop



Get ready for exciting adventures in homecraft with the great new tools that are coming!

You can start today to lay the ground-work for a shop that any home craftsman might envy. A shop where you can do things you hardly thought possible — using the new Delta Power Tools that are on the way — finer, faster, safer, better-looking than *any* pre-war tools.

As we make thousands of Delta Tools for vital war work, we add to the "know-how" that has already established Delta Tools as the finest in the field. You get the benefits, as you create objects that are more beautiful and more saleable, and do it with greater ease, greater safety, and greater pride than ever before.

3 things to do NOW . . .

Though Delta's entire output today is needed for war work, there are three steps you can take now to assure the maximum of enjoyment, healthful recreation, and earnings from your post-war workshop.

1 Get Delta's help in planning
Below you see "How to Plan a Home Workshop," a 56-page book to help you in laying out and equipping an efficient, attractive home workshop. It's packed with practical ideas. It gives you how to information on dozens of subjects, from Shop Layout to Tool Racks.

Let this book help you save time and money, avoid waste of effort and materials. Use the coupon below and send for it today.

2. Build cabinets, accessories
Get ready for the day of "full production." Tool racks, cabinets, storage racks and other equipment can be prepared. Use ideas from the book below.

3. Buy War Bonds with a goal
Decide on the power tools you want. Then "earmark" your War Bond purchases and make your dollars work *two ways* for future happiness.

Only 25¢ "How to plan a Home Workshop." 56 pages of practical, tested ideas and helps - pictures of typical shops — plans, designs, layouts. Fill out coupon below and send it with 25c in stamps, check, or money order.

Tear out and mail coupon today

THE DELTA MANUFACTURING CO.
658M E. Vienna Ave., Milwaukee 1, Wis.
I am enclosing 25c for my copy of "How to Plan a Home Workshop."

Name .....
Address .....
City ..... State .....

What kind of "window blinds" do you want for your home after the war?

TELL US...YOU MAY WIN $200.00* IN WAR BONDS

OR ONE OF THE 41 OTHER PRIZES, TOTALING $500.00

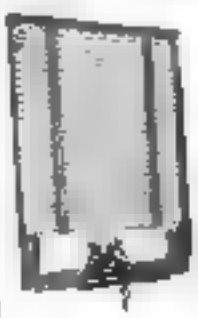
WHAT HAS BEEN DONE

Many years ago, window drapes and shutters were used to regulate light and give privacy

About 1864, the spring roller for cloth shades was perfected. Since then there have been few changes in this roller, or in cloth shades.

Fifteen years ago, CLOPAY perfected and introduced cellulose fiber window shades which looked like expensive cloth shades, but cost about ⅙ as much

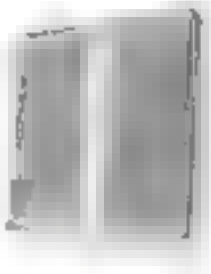
Then women asked: "Why can't you make a shade to attach to our old rollers so we can afford to put up fresh, clean window shades every year?" So CLOPAY invented the gummed strip which makes it easy to attach a new CLOPAY shade to an old roller—without tacks or tools. These "refill" shades still sell for 10c, 15c—with lovely washable ones for only 25c

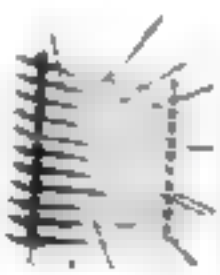


Next, Venetian Blinds for all. CLOPAY developed Venetians with sturdy curved fiber slats that look like the smartest steel and wood Venetians. They cost about half as much - $1.69 to $2.19.

WHAT MIGHT BE DONE

For instance, you may have an idea for a window shade that pulls from side to side. Such a shade could be made.





Or, perhaps you'd like a Venetian Blind with slats of glass or some other material. Maybe you have an idea for an entirely new kind of slatted shade

How about an accordian-type blind—one that lets down from the top, or pulls up from the bottom?

Let's have your ideas and suggestions for the window blinds CLOPAY is planning for the brighter homes of tomorrow. And even the simplest thought may win one of the 42 prizes. It may be a suggestion for a new pattern, color or material ...an idea for improving wearability ...a new way of hanging, pulling or adjusting. Read the easy rules and get busy this very minute.

What's your pet window shade peeve? How would you remedy it? What gets your goat about Venetian Blinds? How would you improve them? Have you a brand-new, bright idea about window blinds?

Your idea or suggestion may be the very one to win that $200.00 in War Bonds* or one of the other valuable prizes. You'll find it fun to try your hand at postwar window shade planning. And wouldn't it be grand to win? Sit down, write your letter, now.

CLOPAY CONTEST RULES

1st Prize	$200 in War Bonds*
2nd Prize	$100 in War Bonds*
Next 40 Prizes	Each, $5 in War Stamps

1. Write a letter telling of what you think is wrong with window shades or Venetian Blinds, what changes you would like after the war. Suggest if you can how these improvements might be made. Or briefly explain any brand new idea you have for window blinds. Write plainly on one side of paper only.

2. Mail your entry to Clopay Corporation, 1270 Clopay Square, Cincinnati 14, Ohio. All entries must be mailed no later than midnight December 31, 1943.

3. Entries will be judged on the basis of originality of idea. Penmanship or fancy entries will not count extra. Decision of judges will be final. In case of ties duplicate prizes will be awarded. But where suggestions are similar, prize will be awarded to entry explaining it most clearly and interestingly.

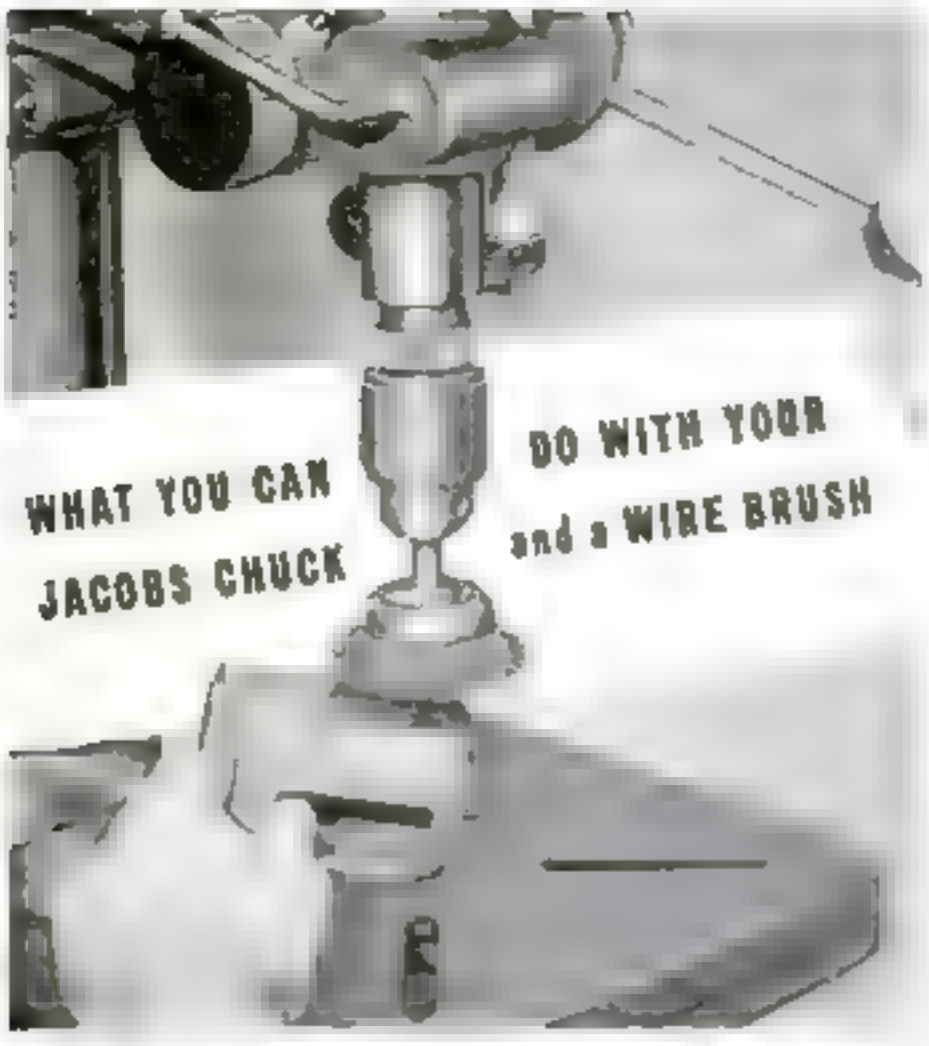
4. No entries will be returned. All entries, ideas and contents thereof become the property of the Clopay Corporation.

5. This contest is open to any resident of the United States or Canada except employees of the Clopay Corporation or its advertising agency and their families, and is subject to all Federal, state and local laws and regulations.

*Maturity value

CLOPAY WINDOW SHADES

On sale at 5-&-10c and neighborhood stores everywhere.

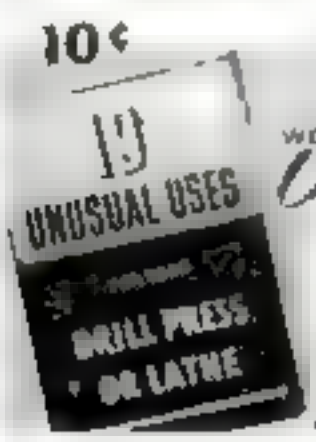


Hard surface deposits that defy ordinary removal methods quickly give way under the harsh, scratching action of the stiff wire end brush. These brushes, held by the JACOBS Chuck in a drill press or lathe, remove rust, baked-on grease, scale, and paint.

In the photo above a small casting is being burnished. Note how the wire brush gives finish to a dull casting. With a softer brush brass, copper, and other non-ferrous metals are given a soft satiny finish.

If You Have A Drill Press or Lathe, or Are Planning on Getting One, You Will Want This Book

The operation outlined briefly here is one of nineteen covered in detail in our new booklet just off the press. It gives practical, helpful information on unusual and varied uses for drill presses and lathes. Printed in color and containing 49 illustrations, it shows how the set-ups are made, illustrates the tools used, and in some instances tells you how to make the tools themselves. If you have a workshop you will want the valuable ideas this booklet contains. If you are planning on having a shop of your own after the war, you will want the booklet now to help you plan.



Jacobs Chucks

WORLD'S LARGEST PRODUCERS OF DRILL CHUCKS

Jacobs Mfg. Co.
2013 Jacobs Road, Hartford, Conn.
Please send me the booklet immediately. I am enclosing 10c to cover handling and mailing costs.

THE THIN GLUE-LINE THAT WON'T CHILL

EVERY DROP WORKS

Spread Franklin Liquid Hide Glue thinly. Its extra strength makes the thin glue-line possible with no chilled joints. FRANKLIN is ready to use; no mixing, no heating.

FRANKLIN
Liquid Hide **GLUE**
AT YOUR HARDWARE DEALER

IF YOUR HARDWARE DEALER CANNOT SUPPLY YOU send 25¢ for ½-pint to The Franklin Glue Co., Columbus 3, Ohio.

ONAN
ELECTRIC PLANTS

Electricity for Any Job—Anywhere

ONAN GASOLINE DRIVEN ELECTRIC PLANTS provide electricity in locations where it is not otherwise available, and for emergency and standby service. Thousands doing a winning job in the war.

Sizes from 350 to 35,000 watts, A.C. 50 to 800 cycles, 110 to 660 volts D.C. 6 to 4000 volts. Also dual A.C. and D.C. output models. Air or water cooled.

Details gladly furnished.

D. W. ONAN & SONS
1909 Royalston Ave., Minneapolis, Minn.

LUBRICATES • CLEANS • POLISHES • PREVENTS RUST

3-IN-ONE Heavy Body OIL

PROTECTS LIGHT MOTORS

At Hdwe., Drug, Grocery and 10¢ Stores

ATKINS

FINE SAWS *deserve* FINE CARE

Atkins "2000" Hand-saw—one of a wide range of types, sizes and styles of quality saws.

● A fine saw is something to be proud of—a tool deserving of special care, particularly in these days when tools are such important weapons on the home front. If your saws are Atkins, you can expect plenty from them in the way of easy handling, accurate work and edge-holding qualities. That's all the more reason to treat them well—to guard them against unnecessary rough handling or neglect.

Send Only 10c for Useful "How To Do It" Book

E. C. ATKINS AND COMPANY
428 South Illinois St., Indianapolis 9, Ind.

SAW

Silver Steel

Buy War Savings Bonds and Stamps regularly.

INTRODUCING-New Victory Model HANDIWELD ELECTRIC ARC WELDER

FULLY GUARANTEED

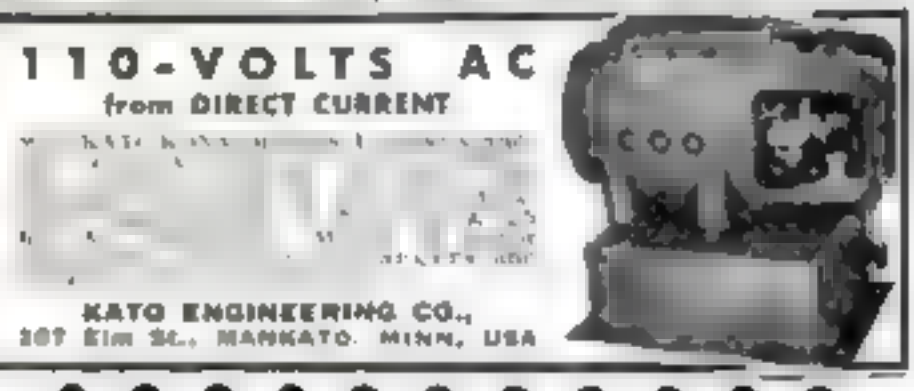
RETAILS ONLY $1.95

PLUGS INTO LIGHT SOCKET

Victory Model Handiweld Arc Welder operates from 11[illegible] volts, A C or D C. current same as other arc we ders higher priced generates tremendous heat to weld a[illegible] metals. Not a toy welder that uses carbons but actually uses standard coated rods—sizes 1 16" and 3 32". However, due to Priorities a generous supply of 1 16" rods on y are supplied with the we der Guaranteed not to burn out Repairs fenders, [illegible] radiators [illegible] etc Take [illegible] anywhere [illegible] operate right from light [illegible] You a find a thousand uses for this welder [illegible] your home garage [illegible] shop A so in [illegible] repair shops tin shops merchants [illegible] farmers etc Or der a Victory [illegible] now SEND NO MONEY. We ll rush one you rods helmet operating instructions and necessary parts with the exception of a large jar and a small piece of extension cord these about everyone has Pay postman only $1 95 p us a few cents postage If not delighted return Victory Model Handiweld in 3 days from receipt and money paid for it will be refunded promptly Rush your order now

KUMFY PRODUCTS INC., Dept. W-205, Cincinnati, Ohio

110-VOLTS AC
from DIRECT CURRENT



KATO ENGINEERING CO.,
207 Elm St., MANKATO, MINN., USA

Clean out car radiators thoroughly before adding anti-freeze. Use

Sani-Flush *10c and 25c sizes Directions on can*

TRAILER BUILDERS' PARTS CATALOG

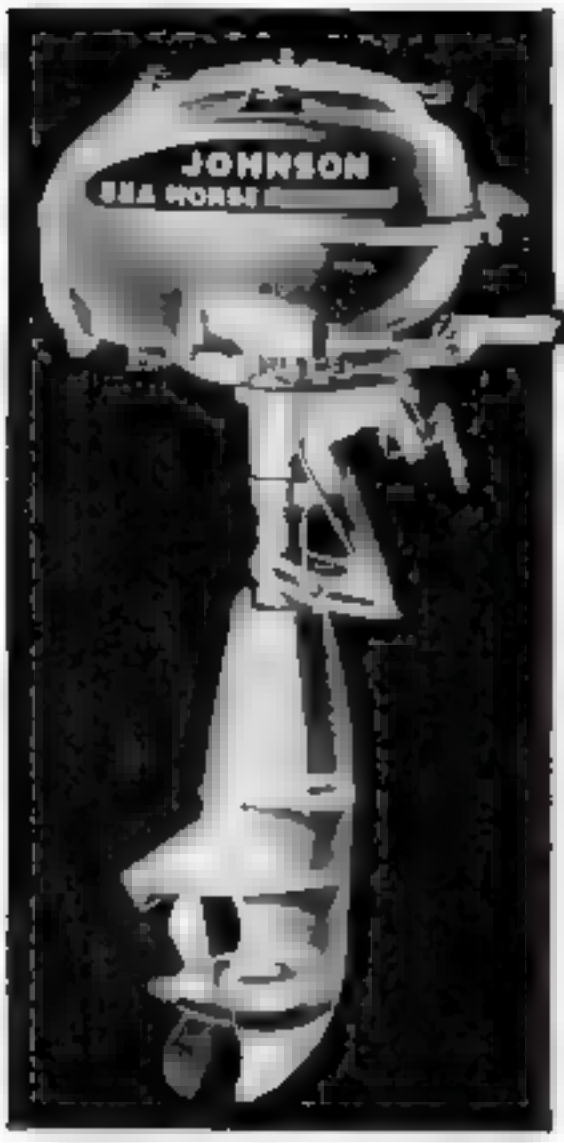
[illegible] you may on ev[illegible] Largest [illegible] Trailer [illegible]

NATIONAL TRAILER EQUIPMENT CO.
719 N Seventh St Milwaukee 3 Wis.

QUICK REPAIRS!

Holes and cracks in floors or baseboard can be quickly repaired with Plastic Wood. Handles like putty, hardens like wood. At Paint, Hardware and 10¢ Stores.

PLASTIC WOOD



THERE IS NO SUBSTITUTE FOR EXPERIENCE

ARMY NAVY

FIRST COUSIN TO A PURSUIT SHIP

The Sea-Horse outboard motor, being a little fellow, doesn't roar. It purrs. But its purr results from the same characteristics that distinguish airplane motors—sheer quality, high relation of power to pounds, and smooth, DEPENDable operation.

Fact is, Johnson used aluminum to revolutionize small motor design way back in the days when intrepid fliers were barnstorming in crates. Stainless steel, chrome, molybdenum and nickel alloys and other fine metals followed until Sea-Horses were composed almost entirely of the materials *most urgently* needed in the Nation's present program of war plane construction.

Today's Sea-Horses are all for the armed services. Tomorrow's Sea-Horses, built out of twenty years' experience, will be revelations in performance. • *Johnson Motors, Waukegan, Illinois.*

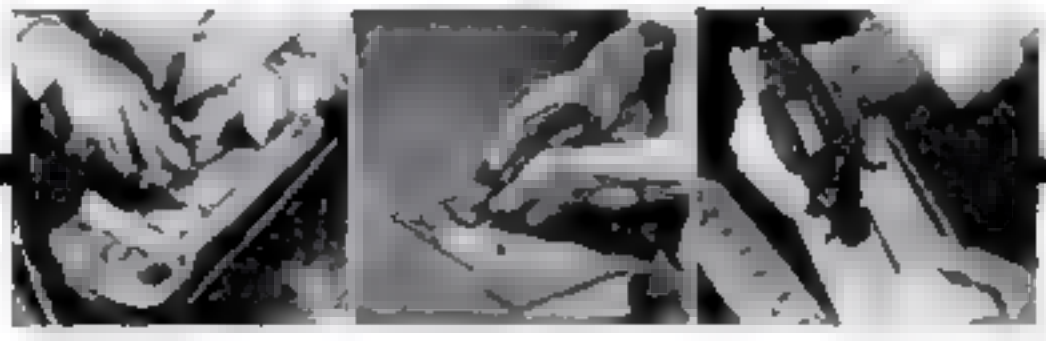
DO YOUR DUTY — BUY WAR BONDS

JOHNSON SEA-HORSES

for **DEPENDABILITY**

The Machine of 1000 Uses

New DURO HAND GRINDER



THE ideal hand grinder for craftsman and model makers. The DURO Heavy Duty Grinder eliminates tedious hand filing, carving, buffing, polishing and scratch brushing. Does delicate, accurate work in fraction of time. Packs plenty of power and speed—24,000 R P M. Powered with fully universal G E. motor. Of streamline design—only 6½" in length. Has approved Underwriters' cord. Collet chuck with capacity up to ⅛". 110-V A.C. or D.C. current, 60 cycles or less. Has many special features including New Departure ball bearings, shock proof motor case, adequate cooling fan, push-button switch. Also available in lighter "Streamline" model at $9.95 and in complete Heavy Duty Grinder Kit at $22.95.

Send for Complete Circular

giving full details, specifications and prices on DURO Hand Grinders—also for catalog of complete line of DURO Machine Tools.

DURO TOOLS

MACHINE TOOL DIVISION

ALSO MAKERS OF DURO HAND TOOLS

Duro Metal Products Company
2653 N Kildare Ave., Chicago, Ill.

Gentlemen. Send me complete circular on DURO Hand Grinders—also FREE copy of latest DURO Catalog.

Name

Address

City. *State*

A PROTRACTOR-RULE and a REPAIR HANDBOOK

both sent FREE if you mail the coupon

Here are TWO handy helps every householder and handy man should have, and which are available without charge to the readers of this magazine.

1—*A durable protractor*, with black letters on a white background for greatest legibility, with angles reading in both directions, and with an inch scale on the straight side.

2—*The 40-page Smooth-On Handbook*, with simple instructions for time-saving, labor-saving and money-saving repairs to household and auto equipment, etc. Illustrated by 170 diagrams.

The instructions in this handbook are based on the experience of thousands of mechanics and repair men, and include much information not to be found in any other publication. Some of the subjects covered:

How to seal cracks in boilers, stoves, water heaters, radiators, pipes, auto engine water jackets, gear cases, etc.
How to stop leaks at seams, bolts, rivets, threaded or flanged joints, etc.
How to tighten loose parts of furniture, apparatus, fixtures, utensils, tools, etc.
How to waterproof concrete, brick or stone floors, walls, cisterns, pools, etc.

Get Smooth-On No. 1 in 1¼-oz., 7-oz. 1-lb or 5-lb container from your dealer, or if necessary from us. For your protection, insist on SMOOTH-ON used by mechanics and repair men since 1895

Send the coupon TODAY to be sure to receive the free protractor and repair handbook before the supply is exhausted.

SMOOTH-ON MFG. CO., Dept. 58
574 Communipaw Ave., Jersey City 4, N.J.
Please send the Protractor and the Smooth-On Repair Book.

Name.....

Address.....

11-43.....

Do it with SMOOTH-ON

Mortite UTILITY TAPE

BETWEEN YOU AND THE COLD

New pliable plastic stops leaks, saves fuel. Weatherstrips windows, doors, baseboards — caulks casements; makes packing, gaskets.

EASY TO APPLY

Unrolls like ribbon. Just press into place and it stays put. Does not crack, chip, dry out or shrink.

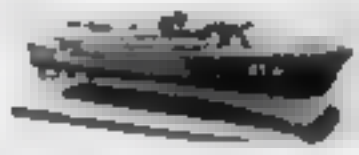
About 80 ft. to box. At Hardware, Plumbing, Mill Supply Dealers or $1.25 prepaid ($1.40 west of Rockies).

Send for Circular

NO DRIP STOPS THAT DRIP

A sure cure for condensation drip from tanks, pipes, walls, ceilings, etc. Apply with brush, trowel or spray. At stores or $1.90 for 1 gal. prepaid ($2.10 west of Rockies). Free Circular.

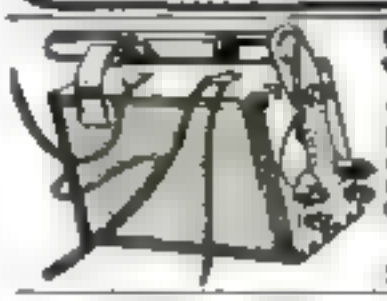
J. W. MORTELL CO. 534 Burch St. KANKAKEE, ILL.



BUILD THIS MODEL
An accurate 13" scale model of the famous PT. Complete kit includes all fittings — Only $5.

GET THIS BOOK — the only one of its kind. Full of detailed drawings and photographs with instructions for building and rigging ship models.

SHIP MODELS ILLUSTRATED
postpaid for only $2.
MARINE MODEL CO., Dept. P, 29 W. 15th St., N.Y.C.



SELL ELECTRIC FENCER

The New HIBALL FENCE KIT is the best yet. Sell dealers or direct. Salesmen make up to $188.64 per gross. Good territory open. 1 Sample, $3.00.

RETAILS $1.95

LEJAY MFG. CO.
2923 Lejay Bldg., Minneapolis, Minn.

OTTAWA TRACTOR SAW

Fells Tree—Cuts Log
Uses Power Take-off any tractor. Direct drive. Long stroke. Saws fast. Easy on fuel. Thousands of satisfied users. Big labor saver. Low in Price.

Write for *FREE Book and Prices*

OTTAWA MFG. CO., D1101 Forest Ave., OTTAWA, KANSAS

WINN'S NEW IDEA HOME LABORATORY CHEMICAL KITS

For High School & College Students. Send for Literature and Retail Supply Catalog

J. H. WINN MFG. CO., Dept. 111
124 W. 23 St., New York 11, N. Y.

SAVE Valuable Paint Brushes!

After every use a DIC-A DOO PAINT BRUSH BATH keeps bristles flexible, useful, new! DIC A DOO Brush Bath will soften and cleanse discarded, hardened brushes—right down to the heel. DIC-A-DOO restores life an I service to bristles—does not leave them limp or flabby. 50 pkg. cleans several brushes. At paint, hardware and 5 & 10c stores. Patent Cereal Corporation Geneva, N. Y.—makers of the famous DIC-A-DOO PAINT CLEANERS.

DIC-A-DOO PAINT BRUSH BATH

USE YOUR BENCH SAW

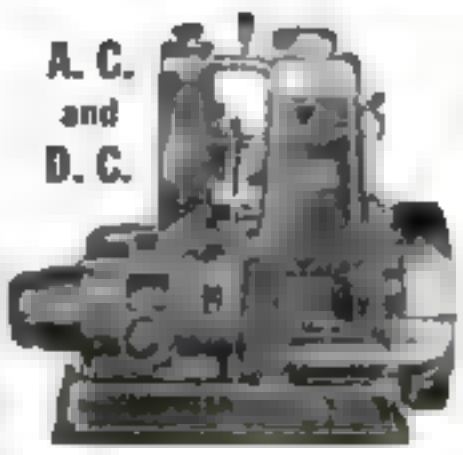
With our six hi speed steel cutters. Make mouldings, casings, drop and tables grooves, beading & coving 1" wide $1.50 1½" $1.75 Postpaid. State size hole. List & folder free.

John A. Sandstrom, Box 517, Stow, N. Y.

Land or Water, "DUCKS" Know Their Way

HULL MFG. CO., P. O. Box 246-E11, Warren, O.

WITTE DIESELECTRIC PLANTS



For 73 years the WITTE plant has been serving America and the World. Today WITTE is producing only for the War Effort. After Victory these improved WITTE plants will be available to all.

Remember us then.

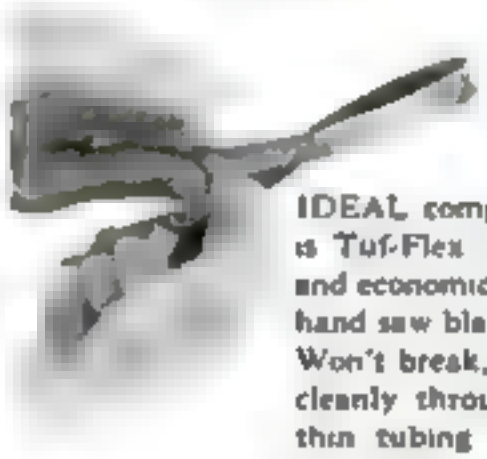
WITTE ENGINE WORKS

LARGEST BUILDER OF SMALL DIESELS

KANSAS CITY, MO., U. S. A.

A NAME WORTH LOOKING FOR when you need quality tools

THE NORMAL Millers Falls line includes hack saw frames in 18 models, each with its special features of serviceability, convenience and economy. "Best of all breeds" for most tool users is No. 48 (illustrated), a higher-quality frame of unusual excellence in design, ruggedness, and value. Rigid, fine balance; polished and buffed finish; comfortable checked Lumarith unbreakable handle. Adjustable for 8 to 12 in. blades.



IDEAL companion for No. 48 is Tuf-Flex, the most efficient and economical general-purpose hand saw blade ever developed. Won't break, won't strip. Bites cleanly through tough rods or thin tubing. A good example of what we mean by "Millers Falls *Quality*."

STANDARD items of excellent reputation in the normal Millers Falls line are 52 sizes and styles of cold chisels and punches, hammer-forged of high grade steel selected for its extreme toughness. Superior heat treating — a Millers Falls specialty — makes these items uniformly the finest quality. Look for the Millers Falls name when you buy, you'll decide the results are worth extra care in selection.

MILLERS FALLS TOOLS

MILLERS FALLS COMPANY — **Greenfield, Mass. U.S.A.**

ARE YOU AN OLD MAN AT QUITTING TIME?

Do you think it's *all right* for you to feel so *fagged out* at quitting time? Do you *know why* you're so tired? With many men it's the *unsuspected* strain and "drag" on delicate, hidden cords that *saps energy* . . . and in many cases these strains can be relieved comfortably with the help of a Bauer & Black Suspensory.

READ THIS FREE ILLUSTRATED BOOK!

It shows and tells how men in all sorts of occupations claim they've found the answer to "QUITTING TIME FATIGUE" . . . *why* they say they *feel years younger* . . . more active . . . more *alive* . . . all through the day!

DON'T FEEL "BUSHED" ANOTHER DAY SEND THE COUPON NOW!

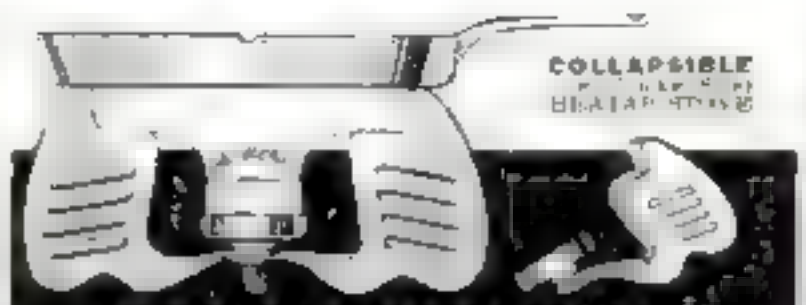
BAUER & BLACK Suspensories
Division of The Kendall Company

Dept. S403
2500 South Dearborn St., Chicago 16
Maybe I'm missing something. Send me your booklet on suspensories . . . quick.

Name _____

Address _____

City _____ State _____



COLLAPSIBLE

"COOK-STOVE" in a VEST POCKET? Yes, Sir! . . and FUEL TOO!

Want a cheery fire, fast? Light a HEATAB! Wet or dry it gives instant flame, long-burning, intense heat . . . outdoors, indoors . . . for cooking, camping, picnics, hunting, fishing, starting furnace, stove or grate fires. Countless other uses by housewives, doctors, nurses, dentists, chemists, industrial workers, Boy Scouts, Girl Scouts, Red Cross and Civilian Defense workers. Needed in First Aid and Emergency Kits. Carried by armed forces to beat combat fatigue. Solid, compact, non-poisonous. NO SMOKE, SOOT, FUMES or ASH!

SPECIAL OFFER—COLLAPSIBLE STOVE (fits vest pocket) included with TWO LARGE BOXES OF HEATABS . . . only $1.00 postpaid . . . ORDER BY MAIL, TODAY!

J. W. SPEAKER CORPORATION
3678 N. Water Street Milwaukee Wis.

"HEATAB" TABLETS OF HEAT

730 SHAVES FROM 1 BLADE

AMAZING NEW BLADE SHARPENER

New sharpener for all makes of double-edge razor blades performs miracles! Not necessary to change blades," writes one user. Another says, "Like a new blade every shave." RAZOROLL puts a keen edge on dull blades because it strops on both sides of blade to keep smooth shaving edges. No guesswork. Blade held at correct angle and proper pressure automatically. Just turn roll to sharpen your blade. So easy. So much. Handsome, compact, sturdy. Weighs few ounces. Will last years. Makes ideal gift.

SEND NO MONEY! Write today. Pay postman only $1 plus few cents postage. Use RAZOROLL for 5 days and if you're not delighted with smooth, velvet shaves you get, return RAZOROLL and we'll refund your dollar. Hurry—order today.

RAZOROLL COMPANY
630 North Michigan Avenue Dept. 2911 Chicago, Illinois

PEPSI-COLA HITS THE SPOT

GERSTNER TOOL CHESTS

are favorites with discriminating toolmakers and machinists everywhere. Free Catalog.

GERSTNER TOOL CHESTS
543 Columbia St Dayton, Ohio

BUILD THE BIGGEST $1.00 PLANE IN U. S.

Huge 7-Ft. Super CONDOR Glider Soars for Hours

Stronger, longer flights, more graceful lines, construction simplified. Easier than ever to build. Kit E-5018 only . . . **$1.00**

Send 5c for new No. 40 Catalog (none free)

Big 3-Ft. Famous War Models

Kit T74—Messerschmitt ME-109. Kit T76—Bell Airacobra P-39. Kit T77—Curtiss P-40 "Warhawk"; Kit T85—P-38 "Lightning". Kit T78—Hawker Hurricane. Kit 791—P-51 "Mustang"

Each Only $1.50 *If your dealer can't supply you, order direct.*

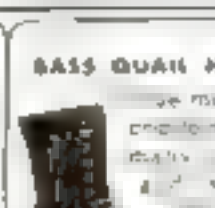
Cleveland Model & Supply Co., 4508C106 Lorain Ave., Cleveland 2, Ohio

THE SECRET of INDIAN FOOT COMFORT

BASS WEEJUNS
American styling and comfort in a moccasin

BASS SKI BOOTS
Here's extra warmth and protection in a boot

BASS SPORTOCASINS
The [illegible] in a moccasin



BASS QUAIL HUNTER

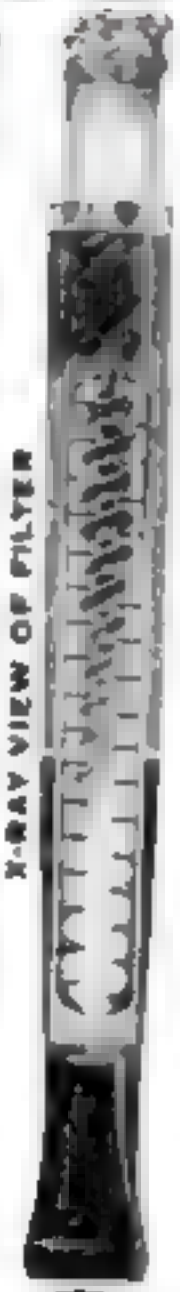
FREE

A fine booklet about Bass Footwear for men and after the war, although some styles are temporarily discontinued. Write G. H. Bass & Co., 410 Main Street, Wilton, Maine.

WEAR · BASS · MOCCASINS

MEDICO FILTERED SMOKING

SENSATIONAL PIPE FILTER ALSO IN CIGARETTE AND CIGAR HOLDERS



No wonder millions have switched to this amazing and revolutionary filter invention—the greatest improvement ever known in pipes, cigarette and cigar holders.

Inside of cellophane exterior are 66 mesh screen "baffles" which whirlcool smoke—retain flakes and slugs, minimize juices, raw mouth, and tongue-bite. Improves taste and aroma of your favorite smoke.

This filter is the "heart" of Medico Filtered Smoking. When discolored, put a fresh one in your pipe or holder. Costs only ONE CENT. Do not miss the benefits of mild, sanitary, Filtered Smoking.

Something wonderful goes on inside

GENUINE FILTERS FOR MEDICO PACKED ONLY IN THIS RED AND BLACK BOX

$1.00

DRILL PRESS OWNERS!

HERE'S 1 TOOL WITH 5 DISTINCT USES

THE BARRON MULTI-PURPOSE ROTARY WOOD PLANER

PLANES & SURFACES • PANELS & BEADS
ROUTS & GROOVES • RABBETS • TENONS

$7.50 COMPLETE

Converts ANY drill press into a time saving, low cost planer, paneler, tenoner etc. Surface finishes all types of tough grained and knotty surfaces to agate smoothness. Safe! Guaranteed harmless to drill press. Thousands now in use. SOLD ON MONEY BACK GUARANTEE. Full refund on 5 day trial. Shipped prepaid on receipt of $7.50—or C.O.D. YOU RISK NOTHING. Free literature.

STEEL TOP AUXILIARY DRILL PRESS TABLE

Has 500 sq. in. smooth working surface. Equipped for shaper and many other important workshop uses—a real buy at **$5.95**

BARRON TOOL CO., INC.
370 Architects Bldg., Detroit 1, Mich.

H&R WARTIME LINE Available Now for Essential Use

THE H&R REISING SEMI-AUTOMATIC RIFLE

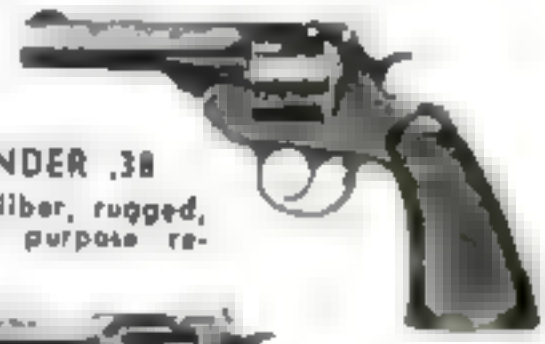
Caliber .45, bottom-fed from 12 or 20 cartridge clip; fires as fast as trigger is pulled; effective range 400 yards, weight with magazine 7 lbs. Excellent weapon for police, guard or military use.

H&R STANDARD

Single barrel shotgun, 12 gauge. Unique action design takes up its own wear

H&R FLARE PISTOLS MARK IV; MARK VI

For ball or parachute flares; 37 mm. and 1" bores.



H&R DEFENDER .38

Five shot, 38 caliber, rugged, precise, general purpose revolver

H&R SPORTSMAN

Nine shot, .22 caliber World-famous for crisp action and balance.

WRITE for your free copy of the Manual of the H&R Reising Submachine Gun. Also now in preparation—a more detailed catalog of the H&R wartime line covered briefly here; we'll reserve a copy for you at your request—will mail it as soon as it's off the press. Harrington & Richardson Arms Company, Worcester 2, Mass., U.S.A.

H&R
FINE FIREARMS

For Sportsmen, Police, and the Military

Buy War Savings Bonds and Stamps regularly.

"Yankee" Fine Mechanics' Tools have contributed to the efficiency of American production for nearly half a century . . . are now working day and night to speed the output of war. Without proper care, however, no fine tools can withstand the punishment of all-out production — and "Yankee" Tools are no exception. Their ingenuity will save time and trouble on the job — if you take the time and trouble to *"Treat 'em Right!"*

"YANKEE" TOOLS

make good mechanics better

North Bros. Mfg. Co., Phila. 33, U. S. A.

Established 1860

Makers, also, of "Yankee-Handyman" Tools

Waiting orders for the dash
Our hero thought he'd take a splash
The land's best bet
Was the Sultan's pet
But the MP's took a flash.

BRIGHT STAR
BATTERIES

You can't buy them as before
When it's over there'll be more

Buy War Savings Bonds and Stamps regularly.

IT'S Free

WARDS 1943 PHOTOGRAPHIC CATALOG

EQUIPMENT AND SUPPLIES
•
EXHIBITION FILM ACCESSORIES

Most everything you'll need, you'll find in our big 1943 Catalog . . . and at Wards moderate prices . . . either cash or Time Payment Terms. Order now and pay later. Get what you want while our stocks are still complete. Act Now . . . Get this money-saving 36 Page Free Catalog.

Montgomery Ward

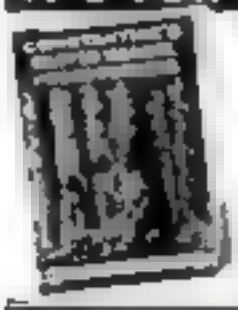
PHOTOGRAPHIC DEPT. PE-1143A, CHICAGO, ILLINOIS

DIE-LESS DUPLICATING

Many small parts can be formed without dies to duplicated accuracy of .001" with DI-ACRO Precision Machines. — Benders Brakes Shears—saving Man Hours and Critical Materials. Require priority of A-1-A or higher. Write on business letterhead for catalog or state if employed in War production.

O'NEIL-IRWIN MFG. COMPANY
347 8th Avenue S. Minneapolis 15, Minn.

IT'S FUN TO MAKE THINGS OF WOOD



CONSTANTINE'S MANUAL TELLS HOW TO DO IT

Big new or expert work find many helpful hints and tips on selecting, working, finishing cabinet making carpentry, etc. Shows pics and explains more than different kinds of wood and ten different items for you. ALL AT MONEY SAVING PRICES. Has color chart showing panel and chart of over 60 rare woods in natural color. A source of supply for anything in wood regardless of quantity. Send only 25c in stamps or coin. Be refunded or credited on first order so Manual costs you nothing.

ALBERT CONSTANTINE & SON, INC.
New York N. Y.

ARMSTRONG TOOL HOLDERS

enabled American Industry to change to war production over night. Now they are the permanent multi-purpose tools used by 9/10 of the machine shops and tool rooms on lathes planers and shapers—the tools used to make dies and jigs to build production machines. They are the tools you will want for your own shop after the war—ARMSTRONG TOOL HOLDERS for industry. ACE Tool Holders for home work shops.

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
328 N. Francisco Ave. Chicago, U. S. A.

LEPAGE'S GLUE

LEPAGE'S MODEL AEROPLANE GLUE
LEPAGE'S LIQUID SOLDER

YOU CAN EASILY MAKE

Telescopes—Magnifiers—Photographic Gadgets and HUNDREDS of EXPERIMENTS with

LOW COST LENSES

Big 10 Page Project and Idea Booklet with all sets—describes successful developments—points the way to new experiments.

ALL LENSES NEW, finely ground and polished, edges very slightly chipped—**A SALVAGE BARGAIN!**

Set No. 301-N "Our Advertising Special" 15 Lenses for $1.00 Postpaid. For making your own powerful telescopes strong magnifiers, photo cells rifle scope telephoto lens DUMMY FOCUSING CAMERA. Kodachrome viewer stereoscopic viewer ground glass and enlarging focusing aids. For experiments, optics, portraits of babies and small pets copying, ultra close-up shots, and many many other uses.

Set No. 308-N "The Gadgeteer's Delight" 35 Lenses for $5.00 Postpaid. Contains all the lenses in the above set plus twenty more expensive lenses increasing your field of experiment and gadget making. All our lenses are neatly packed and marked.

Set No. 310-N "The Experimenter's Dream" 70 Lenses for $10.00 Postpaid. Contains all the lenses in the above sets plus 35 others that makes this a sensational buy. The variety of lenses in this set will enable you to conduct countless experiments and build a wide variety of optical equipment. Here is a real worthwhile investment in many hours of pleasure and benefit.

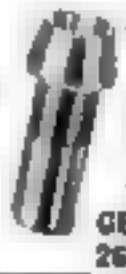
Shopmen! Servicemen! Amateur Photographers!
Stamp Collectors! Experimenters Everywhere!

Get in on this Lens Salvage Bargain Now! Order Today!

EDMUND SALVAGE CO.
41 W. Clinton Ave., P.O. Audubon, N. J.

UP 1/2" LATHE CAPACITY TO 3/4" . . . AN INCREASE OF 50% WITH THE NEW

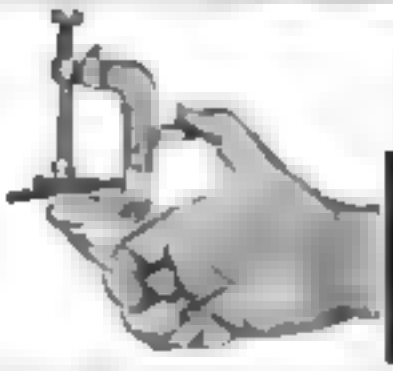
SPEEDICHUK and "PRECISION" BREN COLLET



Revolutionary new invention fits Atlas, Logan, 9" South Bend Lathes and others with 1 1/8"-8 Thread Spindle Nose having a No. 3 Morse Taper on its dr. Write for Catalog "Y" and name of nearest dealer.

GENERAL DIE-STAMPING-TOOL COMPANY
265 Canal Street • New York 13, N. Y.

NEW Things in CLAMPS



GRAND QUICK LOCKCET

The Magic Clamp with Trigger Release

Unequalled for light fast work. Setting the pace in war production. Finger operated. Its long leverage, cam-action converts a press of the thumb into a firm, tight grip. Spring tension and trigger teeth hold firm ratchet grip on screw which **releases instantly** with trigger pressure by thumb or finger so that screw may be slipped to any desired position with a single motion—or, may be immediately reclamped to other work of the same thickness without further screw adjustment. Swinging, locking lever, grip sent makes it absolutely "non-creeping" and assures firm grip on any parallel, slanting or rounded surface. Free acting swivel with fibre face that prevents marring or scarring. Made also with fibre jaws for aluminum and other softer metals. Ask about the complete GRAND Line of Speed Clamps.

Write for Circular

GRAND SPECIALTIES COMPANY
Est. 1921
Grand Avenue at Troy, CHICAGO 22, U. S. A.

"Much credit for the successful maintenance work on both our commercial and military planes is due to the dependability of Snap-on tools, with which the majority of our mechanics work."

Thomas D. Brooks

Superintendent of Maintenance
CHICAGO AND SOUTHERN AIR LINES

ANOTHER GREAT AIR LINE

Endorses Snap-on Tools!

With its far-flung commercial routes supplying swift and dependable transport over the strategic heart of America . . . with giant hangers busily engaged in important modification work for the Army Air Forces . . . Chicago and Southern Air Lines know the importance of good tools in every phase of aviation. Says Thomas D. Brooks, Supt. of Maintenance:

"Chicago and Southern mechanics assigned to both commercial airline and military transport, as well as modification work, have found Snap-on tools adaptable to work where there is very little room available, where the fitting of a tool is of the utmost importance to a dependable job, and where the strength of the tool saves time and in many cases prevents injuries."

Snap-on tools are endorsed by leading air lines, foremost plane manufacturers and engine builders. Their accuracy, flexibility and ease of application meet today's urgent need for speed, and more speed. In victory-geared industry throughout America you'll find them in the hands of men who know tools . . . the choice of better mechanics!

SNAP-ON TOOLS CORPORATION, Kenosha, Wis.

HANDKERCHIEF TEST PROVES VITAL ZONE

Spotless

NO MATTER HOW OFTEN YOU SMOKE IT

SYN-FLO . . .

A NEW MAGIC

LIQUID-PLASTIC ENAMEL

★Finishes walls like TILE

★Finishes woodwork like PORCELAIN

This is really it! Modern science has produced this new white PLASTIC coating you apply with a brush. It actually has the same chemical properties of genuine molded plastic products

A BRUSH-ON PLASTIC

With an ordinary brush you flow this coating on your woodwork and it dries to a smooth porcelain finish—hard, waterproof, abrasion-resistant—stays brilliant white.

You won't have to wait until after the war for this new, scientific, plastic discovery. Limited quantities now available.

MONEY-BACK GUARANTEE

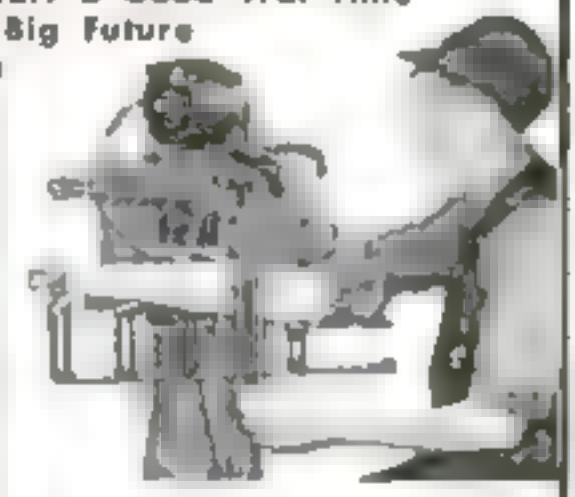
One gallon SYN-FLO Liquid Plastic will cover walls of average room. Send only $5.95 for full Gallon SYN-FLO with Special Thinner, express prepaid. Will ship C.O.D. if desired.

LIMITED SUPPLY AVAILABLE TO PUBLIC NOW ORDER AT ONCE! FREE ILLUSTRATED CIRCULAR ON REQUEST

SUPERIOR PAINT and VARNISH WORKS
2250-2274 W. Elston Ave., Chicago 14

FREE PLAN!

Shows how to Start a Good War-Time Business with a Big Future



SAW FILING

FREE PLAN

FOLEY MFG. CO., 1419 J FOLEY BLDG MINNEAPOLIS 13, MINN

Please send FREE PLAN on saw filing business

NAME

ADDRESS

Buy War Savings Bonds and Stamps regularly.

PHOTO CELL BOOKLET

Includes easily understood scientific details on Emby self-generating photo-cells.

SEND 25¢ for prepaid copy

SELENIUM CORPORATION OF AMERICA
1000 West Pico Blvd. Los Angeles 6, Calif.

Test-O-Lite the MODERN TROUBLE SHOOTER

THE NEON GLOW

. . . LOCATES TROUBLE INSTANTLY in electric circuits, fuses, cut-outs, motors, radios, appliances. Tests everything electrical from 100 to 550 volts. Indicates hot or grounded wires. Tells AC from DC. For superior to ordinary clumsy test bulb

PUTS "FINGER" ON THE TROUBLE SPOT--QUICKLY

Saves precious time. Indispensable in shop or home. Has patented safety features. Vest pocket size with clip. Lifetime guarantee. List $1.50 (Priority AT required) Purchase through regular electrical dealers.

L. S. BRACH MFG. CORP.
55 Dickerson St. Newark, N. J.

This one

HQSH-X7L-KF1S

The National Educational Alliance Brings a "Great University" into Your Home

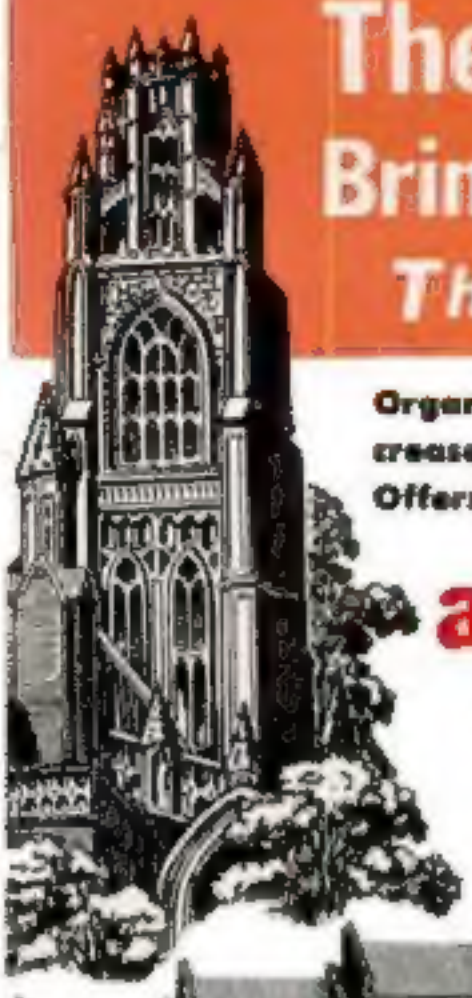
The Higher Education You Need for Success

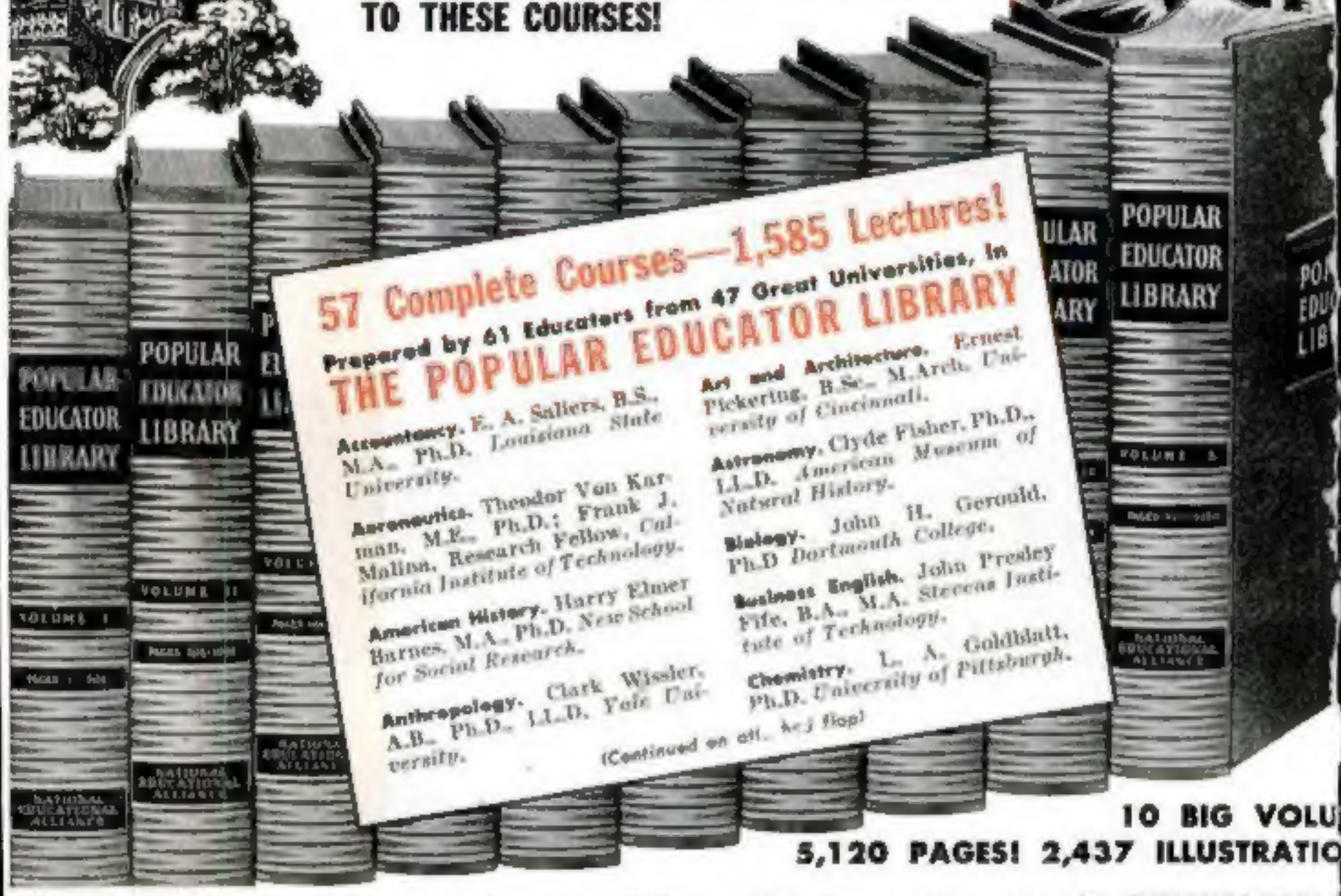
Organized to Help Millions Broaden Their Knowledge and Increase Their Opportunity for Earnings, the ALLIANCE Now Offers Its 57 FAMOUS EASY-READING COURSES in Book Form

1¢ for A LESSON!

at amazingly low cost!

OVER 400,000 PEOPLE HAVE SUBSCRIBED TO THESE COURSES!





10 BIG VOLU
5,120 PAGES! 2,437 ILLUSTRATIO

THINK OF IT! In your own home now you can receive and enjoy instruction by eminent educators especially chosen by The NATIONAL EDUCATIONAL ALLIANCE from such great universities as Harvard, Pittsburgh, Oregon, M.I.T., Minnesota, Notre Dame, Princeton, Pennsylvania, and dozens of others . . . at the miracle rate of about 1c A LESSON!

For the first time all 57 Famous ALLIANCE Courses are available in 10 superb volumes—*the Popular Educator Library!* The higher education you have always wanted is now yours at amazingly low cost!

Just As In College You Study Only the Courses You Want

Think of Studying Courses of Immediate Practical Value . . . ACCOUNTANCY, PSYCHOLOGY, ENGLISH, etc., for only a few cents each!

No matter what your present position and ambitions may be, the ALLIANCE Courses will bring you help to fit your particular needs—practical, positive help to carry you on to the job ahead—to higher earnings and greater accomplishments.

No longer need you believe the old saying that "there is no royal road to knowledge," for the ALLIANCE has surveyed and paved the path for you—and has made a higher education available to all at extremely low cost.

Take, for example, a subject like PSYCHOLOGY. I had to attend lectures on this subject in person at a c it would cost you hundreds of dollars—even a lex would cost you three or four dollars. Yet The NATIO EDUCATIONAL ALLIANCE brings you a complet vey of this science, in 38 lessons, by an eminent edu from Northwestern University—AT A TOTAL COS ABOUT 38 CENTS!

57 Practical Courses for Everyone—Business Man, chanic, Office-Worker, Teacher, Parent, Stud

Courses in Mathematics, Languages, Chemistry, Psych Shorthand and Typing, Business English, Physics; Hi Music, Drawing and Design, Radio, and dozens mo presented in this great educational library.

LAST CALL! The present edition will very soo exhausted. Future editions will to be printed on less substantial p and sold at a higher price. B act at once!

Examine THE POPULAR EDUCATOR LIBRARY Free

—by the Fighting Engineers

When there are tanks to be stopped—watch the Engineers! "Tank block—rush it!" is the order . . . and the photograph at the right *(an actual training test)* shows the result.

Stopping tanks is only a *part* of the job of the fighting U. S. Engineers. And, like men in all the other services, you're apt to find that when an Engineer lights up a cigarette—it's a Camel.

They've Got What it Takes!

First IN THE SERVICE

The favorite cigarette with men in the Army, the Navy, the Marines, and the Coast Guard is Camel. (*Based on actual sales records.*)

The "T-Zone"

where cigarettes are judged

How long since you've smoked a Camel? Give them a try today. Compare them critically . . . for taste . . . for your throat . . . for your "T-ZONE." We believe you will like the extra flavor that Camel's costlier tobaccos give. We believe your throat will confirm the findings of other Camel smokers. So try Camels in *your* "T-ZONE."

BUY WAR BONDS STAMPS

Camels

R. J. Reynolds Tobacco Company, Winston-Salem, N. C.

WANTED AT ON

★ Mathematically Trained M
Ages 18 to 45 and Over-for Ar
Home Front AND Fighting F

This war calls for mechanical ingenuity in America's factories and for scientific efficiency on the battlefront. And mathematics is *basic knowledge* for all mechanical and scientific work. Thousands of mathematically trained men are now needed for the war effort. To serve your country, to qualify for a b bigger responsibilities, bigger opportuniti factory, in the army, navy or air force—l ematics! Now you can master mathematics in your spare time—easily and quickly—a

THE NATIONAL EDUCATIONAL ALLIANCE, INC.

now brings you this up-to-date home-study lecture course in

PRACTICAL MATHEMATICS

in 120 days—at a cost of only 35c a subject!

IN PERIODICAL FORM

Prepared by specialists from leading universities

NO LONGER need you shrink from the "bugaboos" of mathematics! No longer need you stand aside while better qualified men get all the "breaks" in your shop. No longer need you be lost "in the ranks" while mathematically trained men are given special service ratings. You can now learn how to put mathematics to work for *you*—how to use it for more rapid promotion, for a chance to stand out from the crowd, for maximum service to your country! No previous training or elaborate schooling is required to master this brand-new simplified course in mathematics.

Starts With a Review of Simple Arithmetic and Takes You by Easy, Clearly Illustrated Steps and Sample Problems to the Most Advanced Applications

This series of lectures in PRACTICAL MATHEMATICS comes to you in 14 periodical pamphlets, three each month—just like any magazine—at no more than the cost of a magazine! Each issue contains a group of 20 to 30 lectures, with sample workaday problems, self-examinations and answers.

The series starts right from the beginning with "refresher" lessons in basic arithmetic, so that even if you have done nothing with mathematics since your school days, you will soon be at home in your studies. From here the Course takes you, one by one, into the 14 branches of applied mathematics. Each group contains 20 to 30 divisions of each subject, under the directions of specialists in the field. Every step is carefully explained, frequently reviewed, and clearly illustrated. No previous knowledge on your part is expected or taken for granted. Each installment includes a quiz-and-answer supplement especially designed for self-education, so that working by yourself—without a teacher—you master every important branch of mathematics in a period of 120 days or sooner.

You Get Training In Actual Mathematical War Problems!

This is not a dry, abstract, school-room course, but a practical training in the vital applications of mathematics. You learn how to use mathematics in the design, production and operation of guns and projectiles. You learn how to use mathematics in aerial and sea navigation. You learn how to apply mathematics in chemistry, mechanics, electricity, radio. You discover how you can use mathematics for short-cuts in daily shop problems, in the laboratory, in all kinds of figuring. You discover that Algebra, Geometry, Trigonometry, simple Calculus and other mathematical subjects, far from being mysteries, are simply ingenious methods for solving mysteries. By devoting an hour a day to study, you w soon find yourself absorbing the essentials of mat matics with an ease and enjoyment you never thoug possible! The Course will make clear to you ma problems that have often puzzled you. You will find it stepping-stone to the kind of a job where others will come to you for explanation and advice—the kind of a job that means a real future!

How Is the Low Cost Possible?

Ordinarily a Course of this scope would cost hundreds of dollars and take years at college. But the need and demand for mathematical training is today widespread and urgent—so urgent that all precedents of high cost and lengthy study have had to be drastically revised. The National Educational Alliance, with its resources and experience in bringing education to the millions, is the one organization eminently qualified to make this great undertaking possible. It has gathered a faculty in mathematics from America's leading universities—each a specialist in his field (see list on other side of flap)—to prepare the lessons in this reading course. And it has organized this course so that it comes to you in convenient installments—like any magazine—at no more than the cost of a magazine! Think of it—a practical easy, short course in mathematics at the cost of a magazine subscription — the greatest bargain in the educational world! See order form on other side of flap. National Educational Alliance, Dept. 8012, 37 W. 47th St., New York 19, N.Y.

ONLY 25c TO START—STOP WHENEVER YOU LIKE!